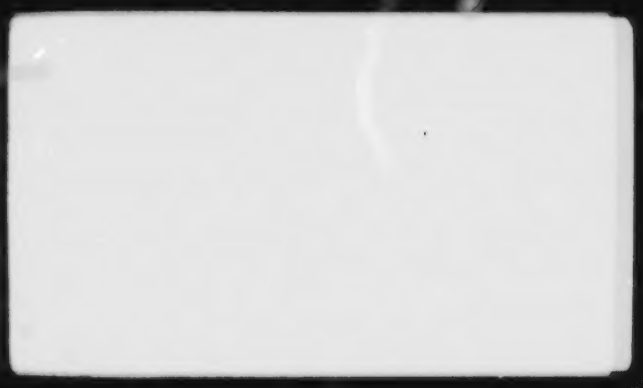
SPARK

REPORT



STRATEGIC
PLANNING
FOR
APPLIED
RESEARCH
AND
KNOWLEDGE

Science
Council of
British
Columbia

SCIENCE AND TECHNOLOGY:
ITS IMPACT ON THE B.C. ECONOMY

A TWELVE YEAR PLAN

JUNE 30, 1988

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PREFACE

The newly created Premier's Advisory Council on Science and Technology and the Science Council of B.C. both have important roles in furthering economic development in B.C. through increased use of science and technology. The Premier's Advisory Council on Science and Technology functions in a confidential, senior level advisory role and has a broad, overall policy setting responsibility. The Science Council of B.C. focuses on the implementation of these policies and works in a more detailed manner at the sector level.

The Science Council of British Columbia started a long range planning process in January of 1987. The mission statement developed in this process was:

> **"To identify and promote opportunities for the Economic Development of B.C. by drawing on the Science and Technology Community for creative applications of innovative science and technology."**

One of the objectives identified as essential to achieving this mission was the completion of sector strategic plans for science and technology in the province. Using its peer review granting committees as a base, with representatives from industry, research organizations, government, the universities and colleges, it launched the process in September 1987. The Science Council of British Columbia, the Premier's Advisory Council on Science and Technology, the Ministry of Economic Development, the Ministry of Advanced Education and Job Training and the National Research Council, all actively supported the process and were represented on a Steering Committee set up to direct the activity.

Each sector committee met four or five times, then produced a draft report. The reports were reviewed by the Steering Committee and then discussed at SPARK (Strategic Planning for Applied Research and Knowledge) Forums, each attended by 30-50 people. In total, this effort represents over 1,000 person-days of volunteer effort.

The sectors reviewed are:

Technology-Users	Technology-Based
Agriculture and Food Processing	Information
Aquatic Resources	Biotechnology
Construction	Manufacturing
Energy	
Forests and Forest Products	
Health	
Mining, Minerals and Metals	

This report captures the views and recommendations of the 500 scientists and engineers from industry, government and research organizations who were involved in the process. It has been drafted by the Steering Committee, reviewed by the sector chairpersons and approved by the Science Council. This summary report should be reviewed in conjunction with its Appendix which highlights the executive summary and recommendations of each sector report. Detailed reports for each sector are available upon request.

We are pleased to place this report before the Minister of Advanced Education and Job Training for review and approval in principle.

Members of Sector
Planning Steering Committee

Chairman - Dr. D. Connor - SCBC
Mr. G. Balcom - SCBC
Dr. M. Cairns - SCBC
Mr. H. Eppich - PACST
Mr. K. French - SCBC
Ms. D. George - MAEJT
Ms. E. Kozak - MED
Dr. P. Larkin - SCBC
Dr. J. McEwen - SCBC & PACST
Mr. D. Miller - SCBC
Mr. D. Mullan - NRC
Mr. J. Ross - NRC

Additional Members of
Science Council of B.C.

Dr. T.W. Calvert
Ms. G.S. Gabel
Dr. D.V. George
Dr. T.E. Howard
Dr. J. Levy
Dr. J.R. MacFarlane
Dr. E.G. Manning
Dr. K.R. Patel
Dr. G.W. Poling
Dr. W.M. Armstrong - Honary Member

Retired Members of S.C. of B.C.

Dr. H. Copp
Dr. J. Dewey
Dr. D. George
Dr. G. May
Dr. I. Warren (deceased)

I EXECUTIVE SUMMARY

This report should be viewed together with the policy for science and technology developed by the Premier's Advisory Council on Science and Technology. This report is intended to complement those policies and to be the more detailed vehicle by which the policies can be implemented.

This report begins by outlining our vision of the British Columbia economy in the year 2000. Then we present our view of where we are now in connection with the twelve steps that will enable us to achieve our vision. Next we outline the major actions and milestones required. We then present the key recommendations from each sector. Finally, we identify (for review, approval and action) essential decisions that need to be made.

Based on an assessment of British Columbia's current strengths and weaknesses, the following twelve point plan is presented to put British Columbia on the path to achieving our economic vision:

1. Form a consensus on the vision and the plan
2. Develop an overall plan for the key resource -- PEOPLE
3. Focus on growth of British Columbia individuals and companies
4. Ensure that industry takes the lead
5. Identify sector champions - continue the planning process
6. Develop university based technology institutes
7. Address the funding requirements
8. Sustain basic research
9. Plan for added value and advanced technology sector growth
10. Stimulate interaction between resource and advanced technology industries
11. Support prototype demonstration projects
12. Continuously work on science and technology awareness

The first year of the plan involves the coordinated execution of seventeen action items. This will require the active participation of and support from industry, the universities and colleges, and the federal and provincial governments. In the short term, it will be important to:

1. Ensure that the Spark plan is coordinated with the other provincial and federal planning initiatives by August, 1988.

2. Increase industry's awareness of and commitment to applied research through their continued participation in sector committees, their support for sector champions and institutes, and through shared funding of major initiatives.

3. Finalize the approval of the requested support from N.R.C., the province and industry so that sector champions can be identified and the implementation program can be undertaken by August, 1988.

4. Demonstrate provincial commitment to this vision and plan by publicizing provincial goals for the year 2000 during the fall of 1988.

5. Approve the policies recommended by the Premier's Advisory Council on Science and Technology by including them in the Throne Speech of Spring 1989 and the Budget for 1989/1990.

II OUR VISION OF THE B.C. ECONOMY IN THE YEAR 2000

We live in a world of competing societies. Thus, it is essential for us to have a clear vision of the kind of society we in British Columbia want. Otherwise, we will find ourselves at the mercy of those societies elsewhere who have such a vision. In that case, our economy in the year 2000 will be one in which our resources will be sold at commodity prices and fewer and fewer people will be employed in the process. The equipment and systems that replace the people employed in the resource industries will be fabricated elsewhere. The value added products that employ our resources will also be made and provide jobs elsewhere. If those industries and jobs leave, the taxes needed to provide for such things as our children's education and health care services for our senior citizens, will not be available. This need not happen! There is an alternative.

Twelve years from now, in the year 2000, the wealth generators in the provincial economy can be, in about equal parts:

- commodity resource products
- value added resource products
- high technology systems and products
- international consulting
- tourism

Such a diversified economy, in a province that cares for its superb natural endowments, will provide an outstanding quality of life for ourselves, our children and our senior citizens.

FORESTS

Our forests will continue to be our major source of wealth and will be harvested on a sustained yield basis. The value added component in wood and pulp and paper products will equal the commodity component. We will be significant exporters of equipment and systems for silviculture, forest management, tree harvesting, wood product manufacturing, pulp and paper and waste management.

The world will look to British Columbia as a major source of forest engineering expertise. The B.C. Advanced Systems Institute will have become world renowned for the forest technology systems research its supports, and it will have close working ties to the Forintek Canada Corporation, Paprican (Pulp and Paper Research Institute of Canada) and FERIC (Forest Engineering Research Institute of Canada). They will be extending and transferring this technology to the forest industry and equipment suppliers. Strong value added wood products industries will be providing increased employment throughout the interior. A particular strength will be the computerized custom wood furniture and prefabricated housing industries centered on Prince George and linked by satellite to sales offices around the world.

INFORMATION TECHNOLOGY (Electronics, Computers and Computing)

By the year 2000, our Information Technology based Manufacturing sector will employ 75,000 people directly and support an additional 75,000 people in the service sector. It will be approaching the size of the forest industry, with major strengths in:

- mobile and personal communication systems and products
- resource industry equipment and systems
- design, integration and testing of large software based systems
- robotic and manned submersibles
- software products
- opto-electronic products
- health care products

Few of the jobs will be in assembly-line factories, however. Instead, these well educated and highly trained people will be involved in design, development, documentation, integration and test, customer support, market research, sales, service and management activities. Volume production will either be done offshore or in automated facilities.

AQUACULTURE AND FISHERIES

Aquaculture and fisheries, along with the associated supply sector, will be a multi-billion dollar industry. By the year 2000, it will be on its way to becoming the second largest resource industry component of the provincial

economy. Salmon, herring, sablefish, oysters, scallops and various seaplants will be cultured in the inlets and bays and on the open ocean areas along the B.C. coast. A strong supply sector will be manufacturing feed and disease control products, and waste management and aquaculture equipment for local and export markets. As a result, coastal communities will be thriving, and strong centers for aquaculture research, disease control pharmaceuticals, and equipment manufacturing will have developed at Nanaimo, Prince Rupert and other coastal communities.

BIOTECHNOLOGY

Biotechnology in the year 2000 will be the second largest high technology component of the provincial economy and will be providing vital disease control, genetic enhancement, and waste management services and products to resource industry and health care customers in B.C. and around the world. In aquaculture, biotechnology will have provided a fast growing, hardy, nutritious and tasty variety of salmon along with a number of disease control products to protect stocks at all stages of their life cycle. In forestry, a number of conifer strains, genetically enhanced for B.C. conditions, will have been produced. Cloned seedlings will be undergoing site evaluation. Tree disease and pest management products will be on the market, and biological agents for converting forest waste to ethanol will be in extensive use. Genetically enhanced biological leaching technology for mineral extraction and mine waste conversion will have been developed and be under test. Biotechnology based health care products will have been developed and tested by B.C. companies and will be curing disease around the world. A Biotechnology Institute will be recognized worldwide for its contributions in basic and applied research in health care, aquaculture, forestry, agriculture and mining.

HEALTH CARE PRODUCTS

A health care products industry will have emerged with many companies developing and producing biomedical devices, home care and chronic care tools, rehabilitation aids, pharmaceutical products and patient health and cost information systems. These industries will not only produce employment and wealth for the province but will also help reduce the ever increasing growth in health care costs.

ENERGY

The province will have been protected from the late 1990's rise in energy costs as a result of the extensive use of B.C. produced natural gas in vehicles and fixed engines. These will have been converted to the use of natural gas by technology developed in British Columbia. An Energy Science and Technology Centre will be a world leader in natural gas, coal, hydrogen and fuel cell technology. This centre will be based on the Advanced Systems Institute concept which coordinates the activities of universities, colleges and research organizations but does not involve building new structures.

MINING

Despite increasing competition from elsewhere, the British Columbia mining industry and its associated equipment supply sector will be healthy in the year 2000. This will occur because the industry will be using advanced systems technology to improve productivity in exploration and mining. Base metal and precious metal deposits will be effectively exploited through the use of improved biological technology and automation. New deposits of industrial minerals will be mined, processed and exported to customers throughout the world. An Advanced Materials Institute will be providing world class technology to our mining industry. Major changes will have taken place in mineral smelting technology.

AGRICULTURE AND FOOD

Agriculture will have adjusted to the free trade agreement with the United States, and will be competitive in high quality and value added products, such as peaches, apples, seed potatoes, dairy products, range fed beef, etc. Food processing and secondary manufacturing industries will be satisfying a large percentage of B.C. requirements.

CONSTRUCTION

Recently constructed buildings and industrial facilities will be costing significantly less to use and maintain, thanks to the new life cycle design technologies developed and used by the B.C. construction industry. This

sector will have raised its awareness of, and commitment to, research and development and coordinated federal and provincial initiatives will have significant impact.

SCIENCE EDUCATION

Our children will be "turned on" to science and technology. They will be graduating from high school and attending universities and colleges in increased numbers. They will be finding high quality jobs in the technology intensive resource industries and the research intensive information technology and biotechnology industries.

Our citizens will be receiving excellent health care at a cost that is affordable by a society that has a growing tax base. In the year 2000, fewer people will be entering the labour force than now. At the same time, an expanding high technology sector, and a growing service industry should result in full employment for British Columbia's working population.

Achieving such an optimistic vision of our economy in the year 2000 will not be easy. Other societies will not be standing still. So, we must assess our own strengths and weaknesses, evaluate the threats and opportunities presented by the global community in which we live, and then make our plans and set about achieving our vision. The alternative vision is unacceptable!

III WHERE ARE WE NOW?

At present, the British Columbia economy has a commodity-based resource focus with growing sectors in the service industries such as tourism, retail and financial. The information technology sector has developed over the past 10 years to become a $1 billion industry employing 10,000 people. The biotechnology sector is at an earlier stage in its growth but promises to become a significant factor. Advanced materials is in its very early stages of development.

Most of the research and development undertaken in the province is done at the provincial universities (supported by federal government grant programs), at the federal government laboratories, at the forest industry research organizations and at B.C. Research. A few of the larger companies have significant research activities. The provincial government provides a small percent of the research and development funds through the Science Council of British Columbia, the B.C. Health Care Research Foundation and line management research laboratories.

POSITIVE FACTORS

In order to achieve the vision outlined previously, we have a number of major positive factors on which to build:

- Our resource industries have become very competitive in commodity products by significantly increasing their productivity through the use of science and technology. Many resource companies are beginning to recognize the need for adding value, and consequently, for becoming involved in research and development.
- The information technology sector has developed over the last ten years into a $1 billion industry and has a world leadership position in a number of key market areas.
- The three universities and the research institutions have sound reputations and a strong capability to undertake research.
- It is obvious from their commitment to the SPARK planning process, that the network of scientists and engineers in the province is dedicated to furthering the use of science and technology in their industry sectors.

- The newly created Premier's Advisory Council on Science and Technology is providing an important role in confidential advice to the provincial government and in recommending overall policy.

- The proposed expansion of TRIUMF will make British Columbia one of a small number of world class nuclear research centres. This will have major economic spinoffs in the high technology sectors.

- The province is considered an ideal location for scientists and engineers to live.

NEGATIVE FACTORS

Unfortunately, there is a negative side. The British Columbia economy, with its emphasis on commodities rather than value added products, has experienced low levels of research and development:

- The province is at the bottom end of the national scale of research and development as a percentage of Gross Provincial Product. Canada spends 1.4% of its Gross National Product on research and development, whereas British Columbia spends .7%. Competing countries such as Sweden, Japan, West Germany, the United Kingdom and the United States spend 2.5% to 3.0%.

- An OECD (Organization for Economic Cooperation and Development) study indicated that Canada is the lowest of eight developed countries in terms of the percentage of its work force who are scientists and engineers working on research and development. All indications are that British Columbia's data would be comparable to Canada as a whole.

- In comparing the relative standards of living of the western countries, Canada was placed in the top one or two countries ten years ago and has now dipped to sixth position. Again, British Columbia's data is comparable.

- A further measure causing concern is the low proportion of our high school students who proceed into post secondary education.

Canada must fully employ science and technology in the years ahead if its economy is to support the ever increasing costs of education and health care. The alternative is a continuing decline in our standard of living.

The unacceptably low portion of the Gross Provincial Product spent on research and development indicates the overall current status of science and technology in the economy. There is a lack of focus and concentrated effort on science and technology within most sectors. A minimum of dedicated resources are available to 'champion' research and development within each sector. Similarly, there is a minimal ongoing organized effort to cause interaction between the sectors, where opportunities for research and development are known to exist. There is a marked lack of coordination amongst many of the national organizations involved with science and technology and also between the national and provincial organizations. There has been a lack of recognition on the part of large segments of industry that science and technology will play a vital role in the future of British Columbia. Therefore, these industries are not actively committed to supporting the research and development needed to protect their prosperity. The overall picture is one of minimal resources being applied to science and technology with a major effort still required to capitalize on the initiatives that have been started to coordinate, plan and monitor activities.

IV HOW TO ACHIEVE OUR VISION

In order to achieve the positive vision of the year 2000 and to avoid the negative alternative, we recommend twelve specific activities be undertaken:

1. Form a consensus on the vision and the plan
2. Develop an overall plan for the key resource -- PEOPLE
3. Focus on growth of British Columbia individuals and companies
4. Ensure that industry takes the lead
5. Identify sector champions - continue the planning process
6. Develop university based technology institutes
7. Address the funding requirements
8. Sustain basic research
9. Plan for added value and advanced technology sector growth
10. Stimulate interaction between resource and advanced technology industries
11. Support prototype demonstration projects
12. Continuously work on science and technology awareness

Now is the time to act. These recommendations must be addressed now in the context of an overall plan agreed to by industry, government, universities, colleges and research institutions.

1. FORM A CONSENSUS ON THE VISION AND THE PLAN

The specifics of our vision of the future can be debated. However, we live in a world of competing societies, and thus it is an inescapable necessity for us to have a clear vision of the society we want in British Columbia and of what we must do to achieve it.

It will require imaginative, yet wholly pragmatic leadership by industry and government to form a consensus on a vision, develop a plan to achieve it, and then implement that plan. Societies around the world, from the resource rich economy of Sweden to the resource poor, high technology economy of Japan, are adopting pragmatic approaches to economic survival in a fiercely competitive world. Any vision and plan we develop must be driven by an understanding of world wide markets and their changing directions. Because industry is most directly in touch with these markets, it must lead the development of our plan to compete on the world stage. However, all elements of our society --- universities, colleges, research organizations and governments --- must be active participants in the process.

The strategic planning process recently initiated by the Premier provides an ideal opportunity to coordinate provincial government activities with the industrial science and technology needs identified in the SPARK process.

2. DEVELOP AN OVERALL PLAN FOR THE KEY RESOURCE -- PEOPLE

The development of the required numbers of people with appropriate skills and motivations is the most significant factor in achieving the science-based vision for the year 2000. Without trained researchers, technologists, tradespeople, entrepreneurs, managers, marketeers and 'enthusiastic technology receptors', we cannot get there.

Two factors underlie the need for a comprehensive people plan.

1. We must significantly increase the awareness of science and technology, and its role in our future prosperity, within all elements of the B.C. society.

2. We must deal with a worldwide shortfall in the future supply of trained scientists and engineers.

In this province, in Canada, and throughout the economies of the western world, the demand for these technical resources is increasing dramatically. At the same time, the number of young people --- the scientists and engineers of the future --- is actually declining. So not only are we seeing fewer young people in the 18-24 year age bracket, but some of the best of them are being attracted elsewhere.

A comprehensive human resource development plan must take these factors into account, relate the anticipated demands for these skilled people to the potential supply, and develop programs to correct the deficiencies.

The task of developing an overall human resource development plan should be addressed by the Ministry of Advanced Education and Job Training, in consultation with all interested parties. Plans must be made now to:

1. Satisfy short term needs for retraining technologists and tradesmen.

2. Attract world class scientists and engineers.

3. Add courses in entrepreneurship, management and marketing to science and engineering programs.

In the medium term, the plan must satisfy the needs of industry by:

1. Enhancing the supply through university/industry scholarships.
2. Adding courses and deleting redundant ones.
3. Directing new funds to the universities and colleges for required courses.

The plan requires increasing the flow of scientists and engineers by influencing elementary and secondary school children's decisions on course selection. At the recent Pacific Region Conference, it was suggested that a practicing scientist or engineer (from Science Council, Premier's Advisory Council on Science and Technology or the universities or colleges), adopt a school and on a continuous basis relate science and technology to the school. This should be done.

3. FOCUS ON GROWTH OF BRITISH COLUMBIA INDIVIDUALS AND COMPANIES

In the main, the society and economy that we want in the year 2000 will have sprung from what is presently here. Thus, the majority of our efforts should be to foster the evolution of our institutions, the entrepreneurship of our citizens, and the steady growth of our successful small, medium and large companies. These efforts must, however, occur in an outward looking context that insists on world class results. The National Research Council industrial support programs provide good vehicles for nurtering local capabilities while maintaining a global technology perspective.

Our education and training programs should equip and motivate people to start and run their own businesses with emphasis on wealth creating businesses. Continuing education programs, delivered to the workplace through interactive television and mobile classrooms, must be available throughout the province to upgrade the skills of owners, managers and employees in growing companies. There is a growing pool in British Columbia of world class expertise in the techniques of entrepreneurship, management, market definition, research, development, manufacturing, sales and service for advanced technology products. Programs to tap this expertise and share it with others must be developed.

The excellent research capabilites in our universities and the federal and provincial governments should be coupled to our economic goals by focussing their applied research activities on challenging pre-competitive research themes defined in conjunction with industry. Mechanisms such as technology institutes, NSERC industry chairs, and the proposed federal-provincial Centres of Excellence program can be used for this purpose.

Advanced technology and value-added resource companies of all sizes that have demonstrated an ability to compete internationally, should be given preference in government procurement policies, special training programs, provincial government efforts to lobby the federal government, specific support initiatives, and financial risk sharing and reward enhancement programs.

4. ENSURE THAT INDUSTRY TAKES THE LEAD

A major weakness in the advanced technology sectors is the lack of a cohesive business association at the provincial level, that can develop and then represent policy positions on the provincial or federal scene. The national associations either are not effectively present here in British Columbia, or are structured so that they do not effectively represent groups outside of Central Canada. We need to encourage business associations in the technology sector, such as the B.C. Division of the Canadian Manufacturers Association, the Electronic Manufacturers Association of B.C., the Software Development Association, the Industry Development Association of B.C., the B.C. branch of Canadian Advanced Technology Association, to come together.

The resource industries and their associations are beginning to realize how important science and technology are to their industry. The broadly based business associations, such as the B.C. Business Council, are not yet at that stage.

To achieve our vision for the year 2000, industry must increase its interest in and support for science and technology. Other recommendations in this report concerning tax incentives and first user risk reduction programs will contribute to this increased participation by industry. It is essential that the technology-user industries make this commitment to increased support for research and development. It is not feasible for government, federal or provincial, to provide the funding required without significant matching funds from industry.

These sectors are now indicating their increased support and are actively involved in identifying sector champions and proceeding with implementation.

5. IDENTIFY SECTOR CHAMPIONS - CONTINUE THE PLANNING PROCESS

Busy people will participate in developing and implementing long term plans for their sector, or for the economy as a whole, provided the effort is sensibly coordinated and supported, and provided they can see some tangible short, medium and long term benefits. The concept of a sector champion for science and technology directed by an industry chaired sector committee addresses all these requirements. Industry, educational institutions, and government would be represented on such a sectoral steering committee. The committee chairman would represent the committee on an overall science and technology steering committee.

The first and most important task of the sector steering committee will be to prepare the job description and then hire the sector champion. This individual should have been actively involved in the sector. The ideal person for this job would be given a one or two year leave of absence from a senior technical or operational management position in industry to carry out the task.

The sector champion would use the recommendations in the sector SPARK report as a starting point, pushing forward those that are ready for implementation, and working with the steering committee to prepare others for implementation. They would interact with other sector champions to develop appropriate cross-sectoral initiatives. In particular, the resource sector champions and the technology sector champions will need to promote extensive interactions between their sectors.

In certain sectors, such as the Information Technology and the Manufacturing sectors, we should consider forming a joint steering committee to direct a single champion for an Information Technology based Manufacturing sector. Such a joint committee would unify this vitally important sector, enabling it to form consensus and initiate action.

The overall steering committee should continue consisting of the industry based chairmen of the sector committees and representatives from the Premier's advisory councils, provincial and federal government ministries and agencies, the universities, colleges and industry associations. It would be supported by resources provided through the Secretariat of the Science Council of British Columbia and by the National Research Council.

6. DEVELOP UNIVERSITY BASED TECHNOLOGY INSTITUTES

Five strategic technologies are crucial to the British Columbia economy:

1. Information Technology
2. Biotechnology
3. Advanced Manufacturing Technology
4. Advanced Materials
5. Energy Technology

Five university based graduate education and research institutes should be developed, with strong industry support and direction, to carry out world class work on problems of long term relevance to the British Columbia economy. The research programs would concentrate both on the needs of the resource industries, including the people/health resource, and on the needs of selected technology sub-sectors such as wireless communication, remote sensing, undersea robotics, systems development, software products, and disease control products. These institutes should be based on the Advanced Systems Institute model; i.e. not new bricks and mortar, but a network to coordinate activities.

1. The B.C. Advanced Systems Institute (ASI) has become a model upon which to base other initiatives. It fostered the creation and now links cross-departmental institutes at each of the three provincial universities. ASI Fellows, who are internationally recognized for their contributions in information technology, are being recruited from around the world. An International Scientific Advisory Board is assisting in their selection, and is working with the Fellows and a British Columbia based Industrial Advisory Board, to define the long term goals for the research program.

2. The Biotechnology Research Centre at the University of British Columbia, in concert with the microbiology departments, other related groups at the three universities and the forest biotechnology group at B.C. Research should be used to form a broadly based Biotechnology Institute. It would carry out research on health care and resource industry problems that invite biotechnology solutions.

3. An Advanced Manufacturing Institute based on the mechanical engineering groups at the three universities should be developed in consultation with local industry.

4. The Centre for Materials Science at the University of British Columbia, combined with related groups at Simon Fraser University, the University of Victoria and B.C. Research, would form the nucleus for an Advanced Materials Institute. A review of the existing research programs and of the needs of British Columbia industry should be undertaken to determine if any shifts in emphasis are needed.

5. An Energy Science and Technology Centre should be formed based on groups at the B.C. Hydro Research Centre, B.C. Research, the three universities and industry. It would define and coordinate energy research programs and arrange for the necessary long term funding.

7. ADDRESS THE FUNDING REQUIREMENTS

There are seven ways in which the required funding for enhancing the use of science and technology can be addressed:

1. Commit to federal and provincial government target funding levels for research and development in British Columbia. This will lead to this province achieving parity with others in Canada and to other developed countries in its percentage of Gross Provincial Product spent on research and development.

2. Complete the approval of the requested funding from the provincial government and the National Research Council for 1988/89 and beyond to continue the planning and implementation process. One million dollars is needed to provide coordination of the overall process, to support the activities of the Steering Committee, to fund six to eight coordinators or champions for various sectors, and to launch initiatives already developed. Industry will need to continue its support through the sector committees and in locating and funding the sector champions.

3. Ensure that Science Council of British Columbia has adequate resources to identify all available sources of funding for research and development so that provincial industry and government funds can be fully levered on federal programs to gain maximum impact.

4. Support the current initiatives of various industry associations and governments to clarify and change the federal and provincial tax structures to make industry investment in research and development much more attractive.

5. Ensure that the $2.9 million that comes to British Columbia each year as a result of the changes in the Pharmaceutical Patent Act goes to medical research and development.

6. Investigate the introduction of a first user risk reduction program to encourage research, development and prototype testing in operational environments.

7. Encourage the support of science and technology by the technology-user sectors of industry so that they can remain competitive.

8. SUSTAIN BASIC RESEARCH

Just as there are certain strategic technologies that are key to the future economic prosperity of British Columbia, there are also certain key areas of basic scientific research that are of fundamental long term importance to the province. Some, such as molecular biology, are directly linked with the strategic technologies. Others, such as particle physics, build on existing world class groups and facilities like TRIUMF to dramatically enhance the science and technology community through initiatives such as the KAON factory.

Strong support for basic scientific research is part of a coherent long term science and technology policy. A strong basic research community is a fundamental component of a science and technology based economy. In order to stimulate more applied research and product development, increases in provincial and federal government funding should be directed at those activities.

9. PLAN FOR ADDED VALUE AND ADVANCED TECHNOLOGY SECTOR GROWTH

The resource industries, with their strong commodity products emphasis, are at present the key engines of the provincial economy. Now, to take advantage of worldwide market requirements, we must focus on adding value in all the resource sectors through the application of science and technology.

The Information Technology based Manufacturing sector has become significant during the past decade by sustaining a remarkable 25% compound growth rate throughout that period. The Biotechnology sector is about where the Information Technology sector was ten years ago. The combination of these two sectors, (hereafter called the Advanced Technology sector), provides a vitally important opportunity for enhancing the wealth generating capability of the resource industries by providing the technology for building strong value added industries and rejuvenated equipment and system supply subsectors. Even more important, this Advanced Technology sector has demonstrated world class strength in a sufficient number of rapidly growing markets that we can expect it to continue at least a 20% annual growth rate given the right environment.

Why do we need the plan? Because, to date the growth of the Advanced Technology Sector has not been large enough to significantly affect the environment that sustains it. However, in 1988 it represents about 5% of the wealth generating portion of the economy, and by 1995, it will represent 15%. As such, instead of its present 10,000 people, it will employ some 30,000 people and will need an additional 6,000 highly trained people in the following year. Ironically, projections by the provincial Ministry of Education show that 1995 is the year in which there will be the fewest people between the ages of eighteen and twenty-four. If the great majority of these new jobs are to be taken up by the children now in Grades 3 to 9 in British Columbia schools, we need to ensure they are being properly equipped and motivated as soon as possible. The object of this plan will be to redirect funding for education to the science and technology areas.

10. STIMULATE INTERACTION BETWEEN RESOURCE AND ADVANCED TECHNOLOGY INDUSTRIES

Very little of British Columbia's advanced technology industry has focussed on the British Columbia resource industries as customers for its products and systems. Given the world class capability of a number of British Columbia resource companies, there is much greater scope for mutually advantageous development programs. The resource companies would benefit by having early access to quality, productivity and value added enhancement technology. The technology companies would develop products or systems with very knowledgeable, "leading edge" customers who could then serve as reference accounts.

In order to encourage closer relationships between the technology and resource sectors, the champions in these sectors should be given the resources to organize a continuing series of well structured forums, symposiums, workshops and trade fairs. Such events bring together key individuals from the relevant sectors where they can become familiar with each others needs and capabilities. The 1987 Advanced Forest Technology Forum, sponsored by the Science Council of British Columbia, the Canadian Advanced Technology Association and the federal Ministry of State for Science and Technology, was an example of what can and must be done. The goal is to diversify by building a strong equipment and system supply sector on the strength of our resource industries, and to ensure that those industries will always have access to the technology they need to remain competitive.

11. SUPPORT PROTOTYPE DEMONSTRATION PROJECTS

The provincial government should establish programs and initiatives to enable British Columbia industry to test and demonstrate new products and processes that have arisen through applied scientific research.

The provincial government's own purchasing activities could act as an example to industry and offer crucial opportunities in this regard. One approach to encouraging such demonstrations is to set up a program of grants or loans to reduce the financial risk to the developer and customer. If the new product or process is a financial success, then the grants or loans are paid back to the government. Still another method of achieving this objective is to use tax incentives for both the developer and the customer. It must be recognized that, in the resource industries in particular, the major risk to a company adopting a new product or process is likely to be lost production, rather than capital cost.

There are various federal models worth the provincial government's review. These include the Defence Industry Productivity Program, IRAP (Industrial Research Assistance Program) grants, "contracting out" and unsolicited proposals. New programs at both the federal and provincial level need urgent consideration. Some, such as the Resource Industry Equipment program being considered for the proposed Department of Industry, Science and Technology, are already in the planning stage.

All these steps are necessary if we are to counter the active support other countries are giving to prototype development and demonstration in non-defence sectors of their economies.

12. CONTINUOUSLY WORK ON SCIENCE AND TECHNOLOGY AWARENESS

A significant enhancement of the level of awareness of science and technology in British Columbia is fundamental to achieving the vision outlined in this report. The scientists, researchers and engineers cannot achieve this vision alone. Alone, they will fail. There must be awareness of and commitment to this vision from government, industry, academic groups, education leaders and the population at large.

The costs of making any real impression on the current levels of awareness of science and technology amongst these various communities are very large. Therefore, it is vital that all involved pull together in a coordinated way. The federal government, the provincial ministries, the Premier's Advisory Council on Science and Technology, the Science Council of British Columbia, Science World and other institutions devoted to science communication, the B.C. Advanced Systems Institute, B.C. Microelectronics Society, Discovery Foundation, the universities, colleges, schools, business and industry must all contribute to and be involved with one plan with one common theme.

Discovery Foundation has suggested that a coordinated and agreed plan should have a common message, logo, and theme that is repeated in all places --- print, television, radio, billboard, letterhead, phone answering, etc. Science Council supports this initiative.

The plan could include general advertising similar to the federal PARTICIPACTION Program and the current Forests Forever program in British Columbia. Also, it should include the 'adopt-a-school' program for key scientists, as well as a program for scientists to visit schools and colleges and business groups in all regions of British Columbia. We should seek to bring international science and engineering conventions and meetings to the province. The B.C. Business Council appears to be the appropriate body to lead other industry associations in raising the profile of science and technology in British Columbia.

V KEY IMPLEMENTATION ACTIONS

To implement our vision for the growth and diversification of the British Columbia economy, it is critical to involve industry, government and the science and technology community. Specifically, the Science Council of British Columbia has set out seventeen actions needed to initiate the process. These coordinated actions will become the responsibility of the existing Steering Committee with its representatives from industry, Science Council of B.C., Premier's Advisory Council on Science and Technology, N.R.C. and the Ministries of Economic Development and Advanced Education and Job Training. They will ensure that the specific recommendations of the sector reports are implemented in a complementary and cost-effective manner. These actions will be the responsibility of a wide range of organizations:

	During
ACTION 1	
Present this report to the Minister of Advanced Education and Job Training.	July 1988
ACTION 2	
Review the recommendations and implementation plan with industry, governments and the science and technology community.	July - August 1988
ACTION 3	
Set up a Steering Committee representing industry, governments and the science and technology community.	July - August 1988
ACTION 4	
Continue to pursue with the Ministry of Advanced Education and Job Training and the National Research Council sources of funding for proceeding with phase II of this planning and implementation process.	July 1988
ACTION 5	
Identify champions for sectors.	June - Sept. 1988

ACTION 6 — During

Move recommendations of each sector along by advocacy, fleshing out proposals, coordinating effort, etc. Start to implement those recommendations that are now clearly identified such as: June - Dec. 1988

- natural gas initiative
- biomedical engineering proposal
- small manufacturers support centre
- robotics for resource sectors
- biotechnology institute
- aquaculture network
- wireless communications research centre
- remote sensing centre
- advanced large scale computing program

These initiatives will need to be coordinated with the centres of excellence program.

ACTION 7

Identify opportunities for levering provincial funding by coordinating efforts with federal agencies. June - Dec. 1988

ACTION 8

Develop and implement plans to involve industry associations and industry in science and technology planning in each sector. June - Dec. 1988

ACTION 9

Continue to develop the role of the B.C. Advanced Systems Institute as a focus for graduate education and applied research in information technology. Begin the planning of similar institutes for bio-technology, manufacturing, advanced materials and energy. June - Dec. 1988

ACTION 10

Undertake a comprehensive review of all people related requirements. Develop a plan to satisfy these requirements. June/88 - March/89

ACTION 11

Continue the current review of proposed centres of excellence and recommend selected centres for provincial/federal funding. June - Sept. 1988

ACTION 12	During
Coordinate SPARK process with premier's strategic long term planning activity. Continue emphasis on coordination of all organizations involved.	On-going
ACTION 13	
Provide input to budgets for 1989/1990 for provincial and federal governments and industry to assist in significantly increasing funding for R&D in the province.	June - Dec. 1988
ACTION 14	
Actively support various initiatives related to tax implications of R&D funding so as to encourage industry investment.	June - Dec. 1988
ACTION 15	
Undertake analyses to identify ways to encourage the growth of more small companies and the evolution of small companies to medium and medium to large.	June - Dec. 1988
ACTION 16	
Review the resource industries to identify ways in which science and technology can improve productivity, increase the value of products and improve utilization of resources.	June/88 - June/89
ACTION 17	
Support science and technology awareness programs.	On-going

VI SECTOR SPECIFIC RECOMMENDATIONS

Detailed reports have been prepared for each of the twelve sectors studied. The executive summaries and recommendation sections of these reports are included under separate cover as an Appendix.

The full sector reports, the executive summaries and recommendations, and this overview report reflect the combined views of the members of each committee, who are listed in the Appendix.

Here is a summary of their views.

1. TECHNOLOGY-USER SECTORS

The forests and forest products; mining, minerals and metals; agriculture and food processing; aquatic resources; energy; health and construction sectors are reviewed.

1.1 Forests and Forest Products

This sector identifies the need to raise awareness within the province of the significance of this sector. It proposes the creation of a provincial forest industry council and the hiring of a champion. It is a key sector in focussing on value added products, improved productivity and increased use of the resource. The need to raise the technology awareness level throughout the industry is critical to ensure an enthusiastic reception for science and technology. The focus on advanced technologies and their interface with the resource sector is emphasized as is the support for advanced machinery and equipment using cooperative research programs and tax incentives to encourage the required research and development.

It is essential that new technologies in the forest sector be transferred as quickly as possible to mills and other operations. At the same time, every effort should be made to increase awareness of and enthusiasm for such new developments. More detailed analyses of the forestry, pulp and paper

and wood products sectors will be undertaken shortly. These will be similar to the one recently completed for the equipment supply sector which is included with this sector report.

1.2 Mining, Minerals and Metals

The major focus is on recruiting a coordinator for research and development to act as an interface between industry and the research organizations and to represent British Columbia's interests with the national mining organizations. One of the key roles will be to increase the industry involvement in research and development and to better utilize the capacity of the universities and the British Columbia Research Corporation (B.C. Research) by developing more industry sponsored research chairs and centres of excellence in areas where British Columbia has a particular interest and inherent advantage.

1.3 Agriculture and Food Processing

This sector requires a significant interface with the biotechnology sector to focus on disease and pest control, genetic improvement and waste management. Value added products and increased productivity in all phases, primary and secondary are key. Significant industry involvement particularly in food processing, secondary manufacture and technology transfer is required. Resource people and funding are needed to pursue these recommendations.

1.4 Aquatic Resources

The development of a network of excellence to coordinate the research and development requirements of the growing aquaculture industry is the priority of this sector. A major interaction with the biotechnology sector in disease control, nutrition, genetics and waste management is needed. Continuing research on specific water quality problems is called for, together with strong support for an aquatic instruments and devices activity. This latter focus can tie in to the recommendations of the information technology sector. In fish harvesting, government and social policies determine the actions required. In fish processing, priorities include the development of new products, adding value to existing ones, better use of by-products, improved quality and packaging.

1.5 Energy

The major recommendation in the energy sector is the need to carry out research on the use of natural gas as a fuel. At first, the emphasis should be on the conversion of diesel truck and urban bus engines to natural gas. The group recommends the establishment of a centre of excellence for energy studies, with industry playing a key role, and government and the universities collaborating. It could become a focal point for energy research and development and for networking information on energy matters.

In addition, a focus on coal is identified. Efforts here should be coordinated with national coal organizations. This sector also recommends the provision of longer term funding than is presently available to continue research into fuel cells and hydrogen.

1.6 Health

This major area of government expenditure requires a coordinated focus on science and technology and encourages the coordination of the Science Council of British Columbia and B.C. Health Care Research Foundation activities. It supports the biomedical engineering centre of excellence, and initiatives in science and technology in nursing, particularly home care and chronic care. Testing facilities and personnel are needed in the pharmaceutical sector. Information technology can be applied to the development of portable bedside workstations, standards for the interchange of health data, health care networking, knowledge of costs, monitoring patients during their lifetime; and in rehabilitation programs for the disabled.

1.7 Construction

The construction sector is recommending a high profile government/industry "kick off" forum to focus on science and technology in this sector. It suggests a series of test projects to encourage innovation in a defined environment where monitoring can occur and litigation can be avoided. It recommends the formation of a Science Council of British Columbia sector committee on construction together with a renewed effort by the universities to focus on industry needs. A key step in raising the very low level of research and development funding in this sector is to get the user/owners aware of this need to push the

industry to reduce the life cycle costs and improve the product delivered. Technology transfer is recognized as a key factor in this sector. The high cost of replacing aging bridges and other public structures is identified as an area for research. The Science Council of British Columbia efforts in this sector are coordinated with National Research Council initiatives.

2. TECHNOLOGY-BASED SECTORS

Here we look at the Information Technology, Biotechnology, and Manufacturing sectors.

2.1 Information Technology

This is a $1 Billion sector employing over 10,000 people. It sees major growth over the next ten years. This will be achieved in part by focussing on the resource industries, to help them be even more competitive, and by continuing the development of its own key strengths in wireless communications, systems integration and software products. It calls for a major commitment to the information technology sector, and a consequent raising of its profile. This will, in turn, attract key people to British Columbia. The marketing, management and technical skills of people in this sector must be developed. A coordination and policy role for a champion is recommended along with increased infrastructure and support.

2.2 Biotechnology

This sector recommends a champion to coordinate all parties involved in the creation of a network of excellence to focus on forestry, agriculture, aquaculture, health, waste management and mining. This coordinated focus would emphasize disease and pest control, genetic improvement and waste management in all these sectors. Increased funding is needed; so is increased industry/ university interaction, and a review of facility needs and coordination.

A coordinated focus on biotechnology is the vital second step in focussing technology on our resource industries, information technology being the first. Biotechnology can have significant impact on the resource sectors if its efforts are coordinated and planned.

2.3 Manufacturing

This sector brings together all of the manufacturing aspects of the provincial economy. A champion is recommended to provide a focus for the sector, to start to reach the 4,000 small manufacturers in British Columbia and to develop a detailed strategic plan. Strong support is provided to the biomedical devices initiative. More manufacturing specific training and education is needed. Marketing and management skills enhancement for those involved in the sector is called for. A small manufacturer support centre is recommended together with a focus on robotics for the resource industries as part of the B.C. Advanced Systems Institute. Since many British Columbia manufacturers are not aware of skills and resources available here, a considerable amount of networking is called for. A continuing focus on Computer Aided Design and Manufacturing (CAD/CAM), on increased funding for research and for technology transfer is called for. The initiatives currently underway in developing manned and robotic submersibles should be encouraged. A first user risk reduction program should be investigated to encourage investment in research and development.

A separate sector group has recently begun reviewing the situation in superconductivity, and recommends a focus on the application of thin films. It encourages the start of a network effort similar to the B.C. Advanced Systems Institute.

2.4 Spinoffs from KAON FACTORY

A major planned program will be required in order to ensure that all possible commercial spinoff opportunities from KAON are realized. This program needs sufficient resources so that the full benefits of having this world class scientific activity in British Columbia are felt throughout the province.

VII DECISIONS REQUIRED

The first year of the plan involves the coordinated execution of seventeen action items. This will require the active participation of and support from industry, the universities and colleges, and the federal and provincial governments. In the short term, it will be important to:

1. Ensure that the Spark plan is coordinated with the other provincial and federal planning initiatives by August, 1988.

2. Increase industry's awareness of and commitment to applied research through their continued participation in sector committees, their support for sector champions and institutes, and through shared funding of major initiatives.

3. Finalize the approval of the requested support from N.R.C., the province and industry so that sector champions can be identified and the implementation program can be undertaken by August, 1988.

4. Demonstrate provincial commitment to this vision and plan by publicizing provincial goals for the year 2000 during the fall of 1988.

5. Approve the policies recommended by the Premier's Advisory Council on Science and Technology by including them in the Throne Speech of Spring 1989 and the Budget for 1989/1990.

SPARK

REPORT

STRATEGIC
PLANNING
FOR
APPLIED
RESEARCH
AND
KNOWLEDGE

Science
Council of
British
Columbia

SCIENCE AND TECHNOLOGY:
ITS IMPACT ON THE B.C. ECONOMY

A TWELVE YEAR PLAN

JUNE 30, 1988

APPENDICES

These appendices are an integral part of the Science Council of B.C. report:

SCIENCE AND TECHNOLOGY:
ITS IMPACT ON THE B.C. ECONOMY
A TWELVE YEAR PLAN
June 30, 1988

These executive summaries and recommendations are extracted from detailed sector plans which are available from the Science Council of B.C.

Agriculture and Food Processing
Aquatic Resources
Biotechnology
Energy
Information Technology
Manufacturing and Machinery
Mining, Minerals and Metals
Forests and Forest Products

MEMBERS OF THE AGRICULTURE AND FOOD PROCESSING SECTOR PLANNING COMMITTEE

Chairperson:

Prof. Beryl March	Dept. of Animal Science, UBC

Members:

Mr. John Berry	Agriculture Canada
Dr. Robert Blair	Dept. of Animal Science, UBC
Mr. Larry Bomford	B.C. Ministry of Agriculture and Fisheries
Dr. R. Forbes	Agriculture Canada
Dr. Les Lavkulich	Dept. of Soil Science, UBC
Dr. Norm Looney	Agriculture Canada
Dr. Hubert MacCarthy	Agriculture Canada (retired)
Dr. Jane Ruddick	Canadian Airlines International Ltd.
Dr. Paul Trussell	B.C. Research (retired)
Mr. Walter Wiebe	B.C. Ministry of Agriculture and Fisheries
Mr. Gavin Young	Orchardist and B.C. Fruit Growers' Assn., and Agricultural Research and Development Corporation

Consultant:

Dr. Peter L. Arcus	Arcus Consulting Limited

EXECUTIVE SUMMARY
of the
COMMITTEE REPORT

Introduction

This report presents the findings of the Agriculture and Food Committee of the Science Council of British Columbia on the opportunities for Science Council to support economic development in B.C. over the period 1988 through the year 2000 by the application of science and technology to the agriculture and food sector in British Columbia.

For the purposes of the review reported here, the agriculture and food sector was defined as

> "That part of the B.C. economy embracing sustainable agriculture, horticulture, and aquaculture, including food production from plants, livestock, poultry, and fish; and the production of beverages, natural fibres, ornamental plants and flowers; and the supplying of inputs to, and the processing and distributing the products of these activities".

The Agriculture and Food Sector in British Columbia is a mature and stable component of the B.C. economy. It represents about $1.6 billion, or 3.7 percent of provincial Gross Domestic Product, per year. Agricultural production utilizes about 10.7 million hectares of land. This is about 11.5 percent of the provincial land base. Much is crown land used for cattle grazing. There are about 19,000 agriculture farms situated on about 2.4 million hectares of land, and about 500 aquaculture (both shellfish and finfish) operations. There are about 6,000 licensed fishing vessels in operation in B.C.

The Agriculture and Food Sector in British Columbia as defined above employs about 58,000 people; about 31,000 in agriculture, about 6,500 in fisheries and about 20,000 in food processing. Additional people work in food service establishments and in food and beverage wholesaling and retailing B.C. Total employment in food, beverage, fibre and horticulture production, processing and distribution is estimated to be about 166,500 people, or about 13 percent of the work force in B.C.

Present Status of Science and Technology in the Sector

Agriculture and food production have developed into sophisticated industries with dependence upon rapid acceptance of innovative technology for maintenance of competitive position in Canadian and world markets.

It is estimated that about $30.2 million per year is currently spent on research and development in the sector. This is about 1.9 percent of provincial Gross Domestic Product. Of this amount, about $24 million per year, or 81 percent, is spent by Agriculture Canada at its four research stations in the province. The work at these stations is primarily long term research, the results of which are aimed at production agriculture and processing.

Research is also undertaken at the provincial universities and within industry. The amounts of the expenditures in these two areas total about $5.7 million per year. Funding is from federal, provincial, and private sources, including, in 1987, about $300,000 from the Science Council of B.C.

The situation in R and D in the sector can be summarized as follows.

i. Funding of agriculture and food research and development has shown a consistently high return on investment.

ii. The B.C. Ministry of Agriculture and Fisheries makes only small contributions to research and these are in support of the more traditional aspects of production agriculture.

iii. There is a relatively low level of industry funding for R & D in the sector although many segments of industry are willing to cooperate in, and contribute in kind to, research projects.

iv. The limited amount of discretionary provincial funding currently available for R & D in the sector dictates that it is practical to support only short-term research and that high risk proposals for technology development or transfer cannot be entertained.

v. There is minimal infrastructure for research in the private sector of B.C.'s agriculture and food industries. The deficiency is partly the result of the small scale of much of B.C. industry and of the "branch plant" syndrome.

vi. There has been a deterioration of the research infrastructure within the Faculty of Agricultural Sciences at The University of British Columbia, and probably at other B.C. universities, as a result of financial inability to replace obsolescent equipment. Operating grant funds are seldom adequate to provide for the capital expenditures on equipment and laboratory instruments.

vii. Innovations in the Agriculture and Food Sector are interrelated closely with activities in the areas of Aquatic Resources, Biotechnology, Manufacturing and Machinery, Information Technology and Energy.

Areas for Action by the Science Council

i. Improvement of production efficiency with emphasis on

a. Biotechnology
b. Pest and disease management technology

These are innovative approaches for improving efficiency. Technologies will be applicable to B.C. agriculture but will also be marketable elsewhere in Canada and abroad - both the technology and the instruments.

ii. Development of high value products from agriculture commodities.

iii. More efficient food processing techniques and improved packaging, storage and distribution processes.

iv. Food safety, environmental protection and waste management.

Recommendations Regarding Actions to be Taken

i. Maintenance of the present Science Council of British Columbia Assistance Grants to Applied Research (AGAR) system with increased funding to enable more effective pursuance of research needed to develop new production and processing technologies and for technology transfer for its industrial exploitation.

ii. Establishment of a mechanism for increasing industrial R & D in B.C. relative to further processing and handling of agricultural products AND of inputs into primary agricultural production.

iii. Financial support for industrial testing of new equipment design, innovative plant procedures and new control instrumentation.

iv. The establishment of Science Council Centres of Collaborative Studies in new product development, pest management technology development, agriculture and aquaculture biotechnology, and environmental protection.

These centres would bring together scientists from universities, government, and industry and research associates, graduate students, and postdoctoral fellows, from throughout the province to research, develop, and test new products and technologies in the designated area. As well, each centre would function as a repository of knowledge and a centre for the dissemination of knowledge.

Recommendations Regarding Actions to be Taken (continued)

These centres would be located at provincial universities. However, each centre might undertake and/or fund activity at other locations such as technology transfer work at industrial sites.

British Columbia is a geographically attractive location for industries. Increased active support for innovative industry by way of RESEARCH SUPPORT and ASSISTANCE IN THE INTRODUCTION OF NEW OR EXPERIMENTAL TECHNOLOGY should encourage the movement of industry to the province.

RECOMMENDATIONS OF THE COMMITTEE

Research and development in the Agriculture and Food sector should build on British Columbia's natural advantages. Significant research and development will be required to capitalize on these advantages. Funding of agriculture research and of food processing research and development has consistnatly shown high returns on investment.

Innovations in the areas of primary production are important for the maintenance of a competitive and increasingly specialized agricultural industry. This industry makes an important contribution to the stability of the social fabric as well as the economic fabric of the province.

Innovation in product development both in the manufacture of new products and in the development of new technology for processing, storage, and packaging is of obvious importance for expansion of the economic base in the province and the creation of new job opportunities, particularly with the possibility of free trade with the United States.

Strategies for addressing the specific development requirements of the most of the many types of production (beef cattle, hogs, tree fruits, vegetables, berries, etc.) involved in the B.C. agriculture and food industry have been developed by industry taskforces consisting of producers and other industry personnel, B.C. Ministry of Agriculture and Fisheries officials, and Agriculture Canada officials. A list of the areas in which these strategies have been, or are being, developed is appended (Appendix B). Many of the resulting strategic plans (strategies) have been published. These plans describe each type of production's requirements for development, including, where recognized, the needs for scientific and technological developments.

The recommendations below relate to the broad areas of needs in the agriculture and food sector. These needs interrelate closely with those in the sectors of Aquatic Resources, Biotechnology, Manufacturing and Machinery, Informtaion technology, and Energy.

Research Areas

1. Applied research in the agriculture and food sector to develop innovative, high value products, and to develop packaging and storage processes which increase consumer satisfaction and convenience, add to product life, and increase market penetration.

2. Research with the potential to add to the efficiency of production in the area of biotechnology in primary agriculture and aquaculture.

3. Research in the areas of pest and disease management in primary agriculture and aquaculture.

4. Research towards increased efficiency of food processing and marketing.

5. Research into food safety.

6. Research on environmental protection and waste management, including soil and water conservation, for sustained productivity in the sector.

Implementation

1. Maintenance of the present Science Council of British Columbia Assistance Grants for Applied Research (AGAR) program with increased funding to enable more effective pursuance of research needed to develop new production and processing technologies and for technology transfer for its industrial exploitation.

2. Mechanisms for greater industry participation in research, development, and technology transfer in the agriculture and food sector.

3. Financial support for industrial testing of new equipment design, innovative plant procedures and new control instrumentation.

4. Funding activities that will lead to faster and more effective technology transfer in the agriculture and food sector.

5. Support for the maintenance and improvement of the infrastructure of teaching and research training in agriculture, aquaculture, and food science in the universities of the province.

6. Establishment of Science Council Centres for Collaboration in new product development, new pest and disease management technology development, agriculture and aquaculture biotechnology, and environmental protection.

MEMBERS OF THE AQUATIC RESOURCES SECTOR PLANNING COMMITTEE

Chairperson:

Dr. Leo Margolis	Department of Fisheries and Oceans

Members:

Mr. David Barbour	Fisheries Council of British Columbia
Dr. Harold Copp	Dept. of Physiology, UBC
Mr. Gordon Halsey	Ministry of Agriculture and Fisheries
Dr. John McInerney	University of Victoria & Bamfield Marine Station
Dr. Brian McKeown	Dept. of Biological Sciences, SFU
Mr. Donovan Miller	Company Director
Mr. Daniel Nomura	Canadian Fishing Company
Dr. Tim Parsons	Dept. of Oceanography, UBC
Mr. William Pennell	B.C. Salmon Farmers Association
Mr. Ron Perkin	Department of Fisheries and Oceans
Dr. Norm Wilimovsky	Animal Research Ecology, UBC

Consultant:

Mr. Wayne Duval	ESL Environmental Sciences Limited

EXECUTIVE SUMMARY

In response to direction from the Science Council of B.C., a sector planning committee met to identify priority needs for research and development in the aquatic resources area to contribute to the economic development of B.C. Our examination led us to the conclusion that substantially increased levels of R & D funding are needed to realize the potentially large economic development benefits from this sector. We recommend that the allocation of such R & D funding respects the following priorities.

Aquaculture: Current investment of more than $300 million and the prospect of substantial employment opportunities were key factors in identifying aquaculture as the most promising area of economic development. Aquaculture R & D priorities were identified as follows:

- Salmon Farming: Genetic selection of better farm stock; improved diets; and solutions to a variety of disease problems, especially bacterial kidney disease (BKD).

- Shellfish: Additional R & D on reproduction, hatchery and nursery technology; genetic improvement; improved processing and handling.

- Product Diversification: Projects whose objectives are the introduction of new aquaculture species.

- R & D whose objective is to alleviate the negative impacts of natural processes on aquaculture crops (e.g., diatom blooms, shellfish toxins).

Other Aquatic Sector Industries: The following priority R & D needs for B.C.'s aquatic sector industries other than aquaculture were identified:

- Water Quality: The mitigation of natural processes or man-made contamination that cause adverse impacts on living aquatic resources, such as undesirable plankton blooms and chemical toxicants. The environmental impacts of aquatic resource industries also need to be examined.

- Aquatic Instruments: Continued support for new instrumentation, especially technology involving optical fibres and hydroacoustics. It was noted that better cooperation between government, universities, and the private sector would greatly enhance R & D in this area and that availability of venture capital for commercialization of promising prototype instruments or devices was a serious problem.

- **Fish Harvesting and Processing:** R & D whose objectives are to improve harvesting, pre-processing and transport, product yield, quality, shelf life, and packaging are all potentially promising areas for B.C.'s fishing industries. In addition, the improved utilization of fish by-product, the commercial development of under-utilized marine resources, and better communication between harvesters and processors are other important areas where improvements are necessary.

In addition to R & D priorities, the Aquatic Resources Planning Committee reviewed existing aquaculture-related R & D and education activities in British Columbia. The committee strongly believes that realization of the enormous potential from aquaculture will require the coordinated efforts of the private sector, educational institutions and government agencies. An **Aquaculture Network of Excellence** with appropriate funding is proposed whose primary mandate would be to foster collaborative and cooperative research in support of the aquaculture industry.

CONCLUSIONS AND RECOMMENDATIONS

This report identifies additional research and development needs within the aquatic sector, including constraints to further research and specific recommendations of the committee in each of five areas expected to benefit the most from future R & D activities. These areas are water quality, aquatic instruments and devices, fish harvesting, fish processing, and aquaculture.

Water Quality

Research needs related to water quality and long-term pollution hazards in B.C. coastal marine environments will depend on industrial growth in the province. The committee concludes that the most significant local concerns that may require further investigation are: (1) the potential effects of relatively new contaminants from changes in the use of industrial chemicals (e.g., tributyl tin [TBT]); (2) adverse impacts of aquaculture operations in areas of limited water circulation; and (3) the natural occurrence of undesirable plankton blooms.

Aquatic Instruments and Devices

Because this industry is considered an integral part of the entire aquatic sector, R & D activities by local firms should be given the necessary financial support. We recommend: (1) continued development of devices and instruments supporting other B.C. aquatic sector industries such as aquaculture; (2) further research on acoustics instrumentation and fibre optic sensors; (3) increased technology transfer and cooperation among the universities, government agencies, and R & D firms engaged in this field; (4) greater funding of efforts to take highly promising products from the prototype to marketable stage of development; and (5) increased cooperation and interaction where appropriate with the electronics and manufacturing sectors within the province.

Fish Harvesting Industry

Major efforts are needed to eliminate potential disincentives arising from existing regulations and harvest techniques. It is recommended that special emphasis be given to the development of more effective harvesting and pre-processing methods. In addition, further cooperative efforts between the electronics sector and this industry should occur in the application of communications technology to enhance information exchange between the harvest and processing sectors, particularly in terms of composition and size of the catch and vessel tracking.

Fish Processing Industry

Additional R & D effort will increase the yield and improve the quality of fish products from fish processors. Incremental improvements in final product recovery will result in significant economic benefits, and increased processing efficiency will also be reflected in higher fish quality. The latter is considered very important because of consumer expectations. At the same time, there is a clear need for R & D efforts to be directed at: (1) new fish products and by-products using presently under-utilized resources; (2) innovative techniques to improve fish quality and extend product shelf-life; and (3) new packaging concepts for existing and future fish products. Opportunities for collaborative R & D programs involving the processing industry, government, and academic institutions should be pursued in an effort to stimulate the necessary research in the above areas.

Aquaculture

There has been rapid growth in the B.C. aquaculture industry over the past 15 years, as well as a significant potential for long-term economic benefits, investment incentives, and employment opportunities in B.C. This could be a billion dollar industry within the next two decades. However, certain existing problems must be resolved to achieve this potential and to ensure continued growth and competitiveness of the industry in world markets. This committee concludes that there is a strong existing base in terms of facilities and expertise for further R & D activities related to aquaculture in the province, as well as substantial benefits to be derived by the industry from various areas of research.

It is recommended that Science Council give support to future R & D efforts in four priority areas:

1. genetics and biotechnology, disease, nutrition, and quality of salmon reared in aquaculture facilities;

2. improvements in hatcheries and nurseries to ensure a plentiful and continuous supply of juvenile shellfish (seeds), as well as increasing the efficiency of grow-out operations; research is also required in controlled gonad maturation, nutrition of larvae and juveniles, and disease control, as well as improvements in handling techniques and long-term genetics;

3. diversification of the aquaculture industry through investigation of the technology required to rear artificially and harvest finfish other than salmon, various shellfish species, and marine plants; and

4. research related to fish kills resulting from high-density phytoplankton blooms.

Finally, this committee recommends that an Aquaculture Network be established to provide the framework for collaborative R & D to provide the necessary support for this growth industry in British Columbia. Our rationale for this recommendation is described in detail in the remainder of this report.

PART II

NETWORK OF EXCELLENCE

Background

The Natural Sciences and Engineering Research Council (NSERC) has proposed the establishment of a number of Networks of Excellence across Canada to provide the institutional framework for collaborative research in specialized areas. These networks would be formed to focus research on high-priority areas, attract and retain experts within a given field, consolidate and expand physical facilities and equipment, and provide the necessary support for growth industries that rely on R & D for their continued economic viability.

On the basis of the information presented in the previous sections of this report, it is clearly evident that the Aquaculture Industry is an ideal candidate for a Network of Excellence and that British Columbia provides a unique opportunity for establishment of such a collaborative framework for future R & D activities. There are persuasive reasons for this conclusion:

1. The aquaculture industry has an enormous potential for producing long-term economic benefits, investment incentives, and employment opportunities in B.C. However, certain existing problems must be resolved to achieve this potential and to ensure continued growth and competitiveness of the industry in world markets.

2. There are active and growing aquaculture-related R & D activities by government scientists, universities and colleges, the private sector, and the industry itself; an informal network already exists among these groups in terms of joint research initiatives and a range of extension programs. A Network of Excellence is needed to strengthen these relationships.

3. Technology transfer and extension activities of the federal and provincial governments, and aquaculture degree, diploma, and instruction programs at academic institutions already exist, and would not only benefit greatly from establishment of a Network of Excellence for Aquaculture within B.C., but also provide much of the necessary framework for its formation and development.

4. There is enthusiasm within the industry for application of new technology and scientific advice, and the scientific and technological expertise necessary for further development of the industry already exists within B.C.

5. The province has 26,000 km of coastline and much of it is sheltered with favourable temperature ranges and climatic and oceanographic conditions for aquaculture; at the same time, coastal waters of B.C. support a diverse assemblage of finfish and shellfish resources that may be the focus of future aquaculture research projects and industries.

Overview of Aquaculture-Related Activities in British Columbia

Department of Fisheries and Oceans - DFO has been actively conducting research on shellfish and finfish aquaculture for the past three decades, with research on salmonid aquaculture occurring before the actual development of the salmon-farming industry in the province, and is the principal focus for aquaculture research in British Columbia. The priority research areas have included culture technologies (including incubation technology), fish and shellfish health, nutrition and diet development, brood stock development, water quality requirements, growth acceleration, genetics, and biotechnologies. The transfer and rearing of salmon smolts in sea pens has also been a focus of DFO investigations, and research on environmental issues associated with salmon netpen farming has recently been initiated. This research has been conducted and is ongoing at the Pacific Biological Station (Nanaimo), West Vancouver Laboratory, and the Rosewall Creek experimental facility of DFO. Within DFO, the Pacific Region Science Sector (Nanaimo and West Vancouver) has been designated the National Centre of Disciplinary Excellence for research in Biotechnology and Genetics for Aquaculture. In addition to salmon aquaculture, the activities of DFO scientists have included research on culture of oysters, clams, roe herring, herring roe on kelp, and halibut, with current emphasis on research on scallop, mussel and sablefish culture. DFO also is involved in undergraduate and graduate student training in aquaculture-related areas, in co-operation with all three B.C. universities and Malaspina College as well as universities from outside the province or country. Through its Subvention Program and financial contributions to the unsolicited proposal program of the Federal Department of Supply and Services, DFO supports university-based and private sector research in aquaculture.

The DFO Pacific Region Science Sector is now working closely with the B.C. aquaculture industry and has established an aquaculture industry-DFO research advisory committee. DFO also has close research links with private sector companies, B.C. Research, and the provincial government aimed at developing high technology products for use in the aquaculture industry.

The establishment of an Aquaculture Centre on the site of the Pacific Biological Station, but managed independently of the Station and outside the Federal Government system, has been planned and is ready to proceed, pending support of the concept by the Provincial Government and the B.C. Aquaculture industry.

DFO also has cooperative research agreements, for various areas of aquaculture, with Norway, the Soviet Union, and the U.S.A.

Provincial Government - The B.C. government has funded and conducted a number of aquaculture research projects. It is supporting a Chinook Broodstock Strain Comparison project in collaboration with DFO, B.C. Research, and the B.C. Salmon Farmers Association. It is also funding the Chinook Broodstock Development Plan being conducted by the B.C. Salmon Farmers Association, with technical direction by DFO and U.B.C. staff. The provincial government also has funded research conducted at DFO's Pacific Biological Station on oysters, mussels, and clams, and is currently providing partial support for research to develop scallop culture methodology and for studies on diseases and parasites of shellfish. In addition, the provincial government has been involved in extension work and technology transfer in aquaculture, including research on fish health.

Other Collaborative Programs - The technology developed to date by the B.C. aquaculture industry, universities, and government agencies has made a significant contribution to international aquaculture projects. There are numerous examples of programs such as those funded by the Canadian International Development Agency (CIDA) and the International Development Research Centre (IDRC), where B.C. aquaculture specialists have used technology developed within the province to assist in similar ventures overseas.

B.C. Research - Some base-budget funds of B.C. Research are directed at aquaculture research, while other studies are conducted under contract to the province and the aquaculture industry itself. The two primary areas where B.C. Research has been active are in broodstock work and fish health, particularly in disease screening.

Malaspina College - Malaspina College in Nanaimo has been active in the aquaculture sector for several years. It offers a 2-year training program in Aquaculture and Fisheries Technology, and is involved in disease screening of salmon broodstock for the B.C. Salmon Farmers Association. Research on sturgeon culture is conducted by college staff and students. An informal arrangement for technology transfer between the Pacific Biological Station and Malaspina College has existed over the last few years.

Universities - Aquaculture-related topics have often been included in fisheries and biology courses offered for a number of years by the three B.C. universities. However, each university now has specific undergraduate and/or graduate programs that provide training in the aquaculture field. An aquaculture course, covering a broad spectrum of subjects, is taught at the University of Victoria; a masters level program and some undergraduate courses

in aquaculture, including special courses on nutrition, aquacultural economics, resource management, and diseases are offered at Simon Fraser University; and the University of British Columbia has initiated an undergraduate aquaculture program. In addition, research on fish nutrition has been conducted at the Animal Sciences Department, U.B.C. for several years, and there has been much other work applicable to aquaculture at this institution. Simon Fraser University has conducted research on seaweed culture and recently initiated research on salmon diseases and their control in aquaculture, as well as on growth and nutrition. An Institute of Aquaculture also has been established recently at Simon Fraser University. The general research capacities of each university in many fields are also of considerable benefit to the aquaculture industry.

Western Canadian Universities Marine Biological Society (WCUMBS)- Research on marine plants and shellfish aquaculture, in cooperation with industry, has been conducted at the Bamfield Marine Station on the west coast of Vancouver Island. During the past 15 years, numerous reports on aquaculture-related research have been published and several aquacultural enterprises have begun or are at a pilot scale level of development. Plans are currently underway for expanded R & D work, supportive of the aquaculture industry, especially on marine plants, invertebrates, and alternate fish species.

Aquaculture Industry - The industry conducts some salmon broodstock research itself and provides funds for work on salmon disease screening. It also has conducted research on shellfish culture, particularly development and improvement of bivalve hatcheries, devising methods to collect natural sets of bivalves, development of a nursery system, and improvement of grow-out technology for oysters, scallops, and clams.

B.C. Salmon Farmers Association - This association promotes aquaculture research and contributes to the planning and funding of such research. It also assumes a role in the transfer of information and technology related to salmon aquaculture through preparation and distribution of information brochures and technical manuals and organization of workshops.

Establishment of an Aquaculture Network

The concept of networking and the establishment of networks comprise a set of practical techniques to achieve strategic goals. Here, networks may be defined as the institutional framework for coordinated and collaborative research in specialized areas when the expertise is found within several organizations or at a number of sites in the same general region. There are many approaches to networking. The literature on networks is vast and most of it pertains to the communications aspects (i.e., transfer of technology and data), rather than the organizational models which can make best use of this administrative structure.

The objective of the network would be the enhancement of aquaculture as a commercial endeavour in British Columbia through the matching of industry needs and R & D capabilities to solve the existing problems and develop new opportunities, as well as to the transfer of technical findings to the user. Cooperative thrusts by industry, research and education could further enhance development of the excellence already existing in aquaculture within British Columbia.

To meet the aforementioned objectives, a potential model might include the following elements:

- Industry input
- Technical assessment
- Research/educational groups
- Technical transfer
- Support funding
- Monitoring
- Coordination including networking and administration

Participation in the network would not preclude any organization from seeking and using separate funding (e.g., as in areas involving proprietary research).

Early benefits of an aquaculture network would include:

- efficient use of expanded R & D funding
- effective joint participation in solution of core industry R & D problems (e.g., the BKD disease problem)
- satisfaction of industry requirements for technical knowledge and personnel (e.g., educational and academic fellowships)
- enhancing experimental facilities for fish, shellfish and plants (e.g., several sites and facilities requiring support).

There is widespread interest within industry, government, and the educational community for cooperative and collaborative aquaculture research. Several substantive analyses document existing enthusiasm and support. Only the critical funding is lacking. Ample expertise exists to develop the functional components in a more substantive way but it is important that such an effort consider all potential participants. Therefore, it is suggested that an ad hoc body be formed, possibly under the aegis of the Science Council, to provide details of a functional model and seek the response of the aquaculture community. This task would require a relatively small amount of funding but needs a statement of conditions of potential support. We believe that any of the alleged areas of difficulty in networking could be resolved through this process.

Implementation of the aquaculture network within a reasonable time frame would require only formal adoption of the mode of the network and core funding. The people and physical facilities are in place to inaugurate this proposal.

Conclusions and Recommendations

The Aquatic Resources Sector Planning Committee highly recommends establishment of a Network of Excellence for Aquaculture in this province. This Network could coordinate the efforts of various complementary research groups and attract additional expertise to the province. It would provide greater opportunities for interaction within the aquaculture research community, and lead to further industry confidence, economic benefits, and capital investment by virtue of a much broader base for future technological development and innovation. It could also assist in the identification of future research requirements, the most appropriate agencies or organizations to conduct this research, and possible avenues for funding of specific projects.

MEMBERS OF THE BIOTECHNOLOGY SECTOR PLANNING COMMITTEE

Chairperson:

Dr. Terry Owen	Helix Biotech Ltd.

Members:

Dr. J.A. Dangerfield	Forintek Canada Corp.
Mr. Michael Gordon	Pacific Aquafoods
Mr. Klaus Jensen	Giant Bay Resources Ltd.
Dr. P. Larkin	Office of the President, UBC
Dr. B. McBride	Dept. of Microbiology, UBC
Dr. J.C. Mueller	B.C. Research
Dr. John Shrader	Biomedical Research Centre, UBC
Dr. Michael Smith	Biotechnology Lab, UBC
Dr. T. Trust	Dept. of Biochemistry & Microbiology, University of Victoria
Dr. Paul Webb	B.C. Research

Consultant:

Mr. David Dyck	Helix Biotech Ltd.

Biotechnology is defined in this report as the application of biological organisms, systems or processes to manufacturing or service industries. Newer technologies involved are immunology, cell fusion, recombinant DNA, tissue culture and fermentation. Biotechnology is a universal "toolbox" that can be applied to a wide variety of industries and it has global importance.

From the responses to a survey of biotechnology organizations, discussions among the committee members, and an open forum, three applications of biotechnology emerged as being most important to the province - disease control, genetic enhancement and waste management. These are critical to the sectors of forestry, health care, agriculture and aquaculture and are areas in which B.C. has existing strengths. This focus is not intended to limit opportunities in other areas or emerging applications of biotechnology. Rather, it is proposed as a means to priorize those applications which appear to have the greatest impact at this time. As biotechnology develops further in B.C., new priorities may emerge.

A. The following actions are required in these three areas.

1) Disease control - The control of bacterial, viral and pest diseases in forestry, health care, agriculture and aquaculture is required. This involves the development of products such as diagnostics, monoclonal antibody targeted therapeutics, vaccines, specifically designed drugs, immune modulators and biological controls.

2) Genetic enhancement - The application of recombinant DNA technology, cell fusion and tissue culture is required to genetically improve important species in agriculture, aquaculture and forestry. This will result in disease resistant, chemical resistant, faster growing, and otherwise improved organisms that are commercially important.

3) Waste control - Development of waste control processes for agriculture, aquaculture and forestry is required to develop methods for detecting low level toxicants, deodorizing and detoxifying effluents and biological wastes, composting of solid wastes, and <u>in situ</u> detoxifying contaminated soils.

B. Recommendations

1) It is recommended that a <u>long term, consistent</u> commitment be made to funding for biotechnology, as the development of new products and processes can take many years.

2) It is recommended that the Science Council of B.C. seek increased funding for these three strategic biotechnology areas: disease control, genetic enhancement, and waste management. As biotechnology is an emerging industry that can have great impact on areas that are important to the economic development of B.C., it is recommended that the increased funding be made available in staged amounts that reach $30 million per year within five to ten years.

3) It is recommended that the governments enhance strategic research capabilities and training of new students. More scholarships and postgraduate grants should be made available to address the shortage of skilled personnel in the province.

4) It is recommended that the B.C. Science Council and the governments foster further collaborations between the universities and the private sector through student and faculty exchanges, network development, joint ventures and technology transfer.

5) It is recommended by university representatives of the committee that more facilities be constructed for biotechnology. The committee suggests that more efficient, coordinated use of existing facilities is also required.

C. ACTION

The committee recommends that the Science Council of B.C. form a provincial biotechnology steering committee to ensure that the recommendations discussed above are carried out in an efficient, productive manner. This committee would advise the Science Council of B.C. and the government on matters of funding, facilities and personnel. It is also suggested that the committee could engage in the following activities.

1. Collect and priorize input.
2. Direct and focus activities.
3. Supervise funding decisions
4. Supervise task forces in the following areas.
   a) disease control
   b) genetic enhancement
   c) waste management
   d) new technologies and opportunities
5. Maintain a public relations and marketing campaign for dissemination of information.

6. Act as a champion for biotechnology.
7. Coordinate networking, collaborations, and technology transfer.
9. Coordinate interaction with other sectors.
10. Coordinate personnel requirements.

IX. RECOMMENDATIONS

1) It is recommended that a long term commitment be made to funding for biotechnology, as the development of new products and processes can take many years.

2) It is recommended that the Science Council of B.C. seek increased funding for these three strategic biotechnology areas: disease control, genetic enhancement and waste management. As biotechnology is an emerging industry that can have great impact on areas that are important to the economic development of B.C., it is recommended that the increased funding be made available in staged amounts that reach $30 million per year within five to ten years.

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C. ACTION

The committee recommends that the Science Council of B.C. form a provincial biotechnology steering committee to ensure that the recommendations discussed above are carried out in an efficient, productive manner.

MEMBERS OF THE ENERGY SECTOR PLANNING COMMITTEE

Chairperson:

Dr. Edward Auld	Dept. of Physics, UBC

Members:

Dr. Philip Hill	Dept. of Mechanical Engineering, UBC
Mr. Chris Lok	Westcoast Transmission
Mr. Kirk McMillan	Canadian Forest Products
Dr. Roy Morrison	Dept. of Physics, SFU
Mr. Peter Nield	Carroll-Hatch Associates
Dr. Mike Papic	B.C. Hydro
Mr. Peter Sandland	Energy, Mines & Resources Canada
Mr. Robert Woodley	B.C. Hydro

Consultant:

Mr. Peter Midgley	Canadian Resourcecon

Executive Summary

The Province of B.C., with its wide variety of energy resources and expertise, has a real opportunity to play a significant role in the development of these resources in a way that will spin off new technologies and marketable expertise.

There are several specific opportunities where more planning, effort and financial support would yield considerable benefits. The basic thrust of the committee's recommendations deals with both the resources and the expertise, namely:

1. Significant planning and funding should be put in place to pursue the research into the natural gas vehicle and engine.

2. More money and coherent support should be available for the curiosity driven scientific research into energy. Herein lies the basic training ground for the next generation of experts. A Centre of Excellence for Energy Studies would address many of the present deficiencies in R & D in the Province.

1.0. Introduction

Research and Development in Energy should be pursued in B.C. for two major reasons: to exploit the unique opportunties of our various energy resources and to provide the ability for our industries to a) switch to the optimum energy source and b) manufacture and market the technology for and using these energy sources.

"In Canada and in other industrialized countries the dominant source has changed over time, from wood to coal and from coal to oil."[1] We are now into an era where a wide variety of sources are competing, especially in the industrial sector. Oil, however, remains dominant in other parts of the economy, especially in transportation.

"The substitution of other transportation fuels for oil continues to pose technological challenges. Examples of potential alternative fuels include methane methanol or ethanol, liquified coal and hydrogen. Given the size of the transportation sector (it accounts for about 25% of all energy use) and its strategic importance, a truly diverse energy system cannot be said to exist until these technological challenges have been overcome".[1]

In the short term emergency measures could help in allowing us to ride out another "oil crisis", but we cannot be as elastic in our response now as we were in 1973. More fundamental long term solutions must be found and the barriers to further limit oil demand are considerable:

a) The demands for all forms of energy, including oil, will increase due to economic growth and demographic changes.

b) New resources of oil are becoming increasingly costly and difficult to find.

c) Many of the least costly substitution and conservation opportunities have already been exploited.

d) There are significant economic and technological limitations to substitute in transportation.[1]

The Province of B.C., with its wide variety of energy resources and energy expertise has a real opportuntity to play a significant role in the transition away from an "oil" economy.

The basic thrust of the committee's recommendation for energy research have a two-fold theme:

a) Significant planning and funding should be put in place to pursue the research into the natural gas vehicle and engine.

b) More money and coherent support should be available for the curiosity driven scientific research into energy. Herein lies the basic training ground for the next generation of experts.

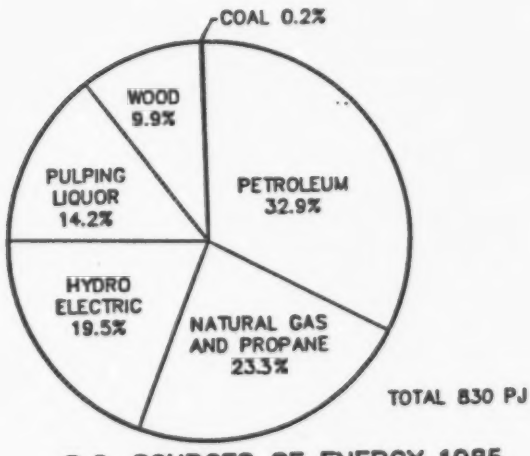
The research success stories for the next decade will be determined by many factors, but it can only happen with well educated scientists and engineers. Economics and politics as well as the new technologies will all have a bearing on the future, so patience, stamina and versatility must be built into the R & D planning.

Full coverage of the energy sector is impossible given the time constraints on this report; however an overview of most aspects is given with an in-depth study of certain selected topics. Section 2 looks at our energy sources; (2.1) the present status of consumption; (2.2) developments in exploration, production and transportation; and (2.3) storage and conversion processes. Section 3 looks at some aspects of how energy is consumed and looks in detail into natural gas as an alternative fuel for engines. Section 4 deals with manpower training and Section 5 with the environment. Section 6 briefly describes some of the new technologies. Section 7 covers some aspects of the management and planning for the future in energy research. The recommendations are summarized in Section 8.

2.0. Our Energy Sources:

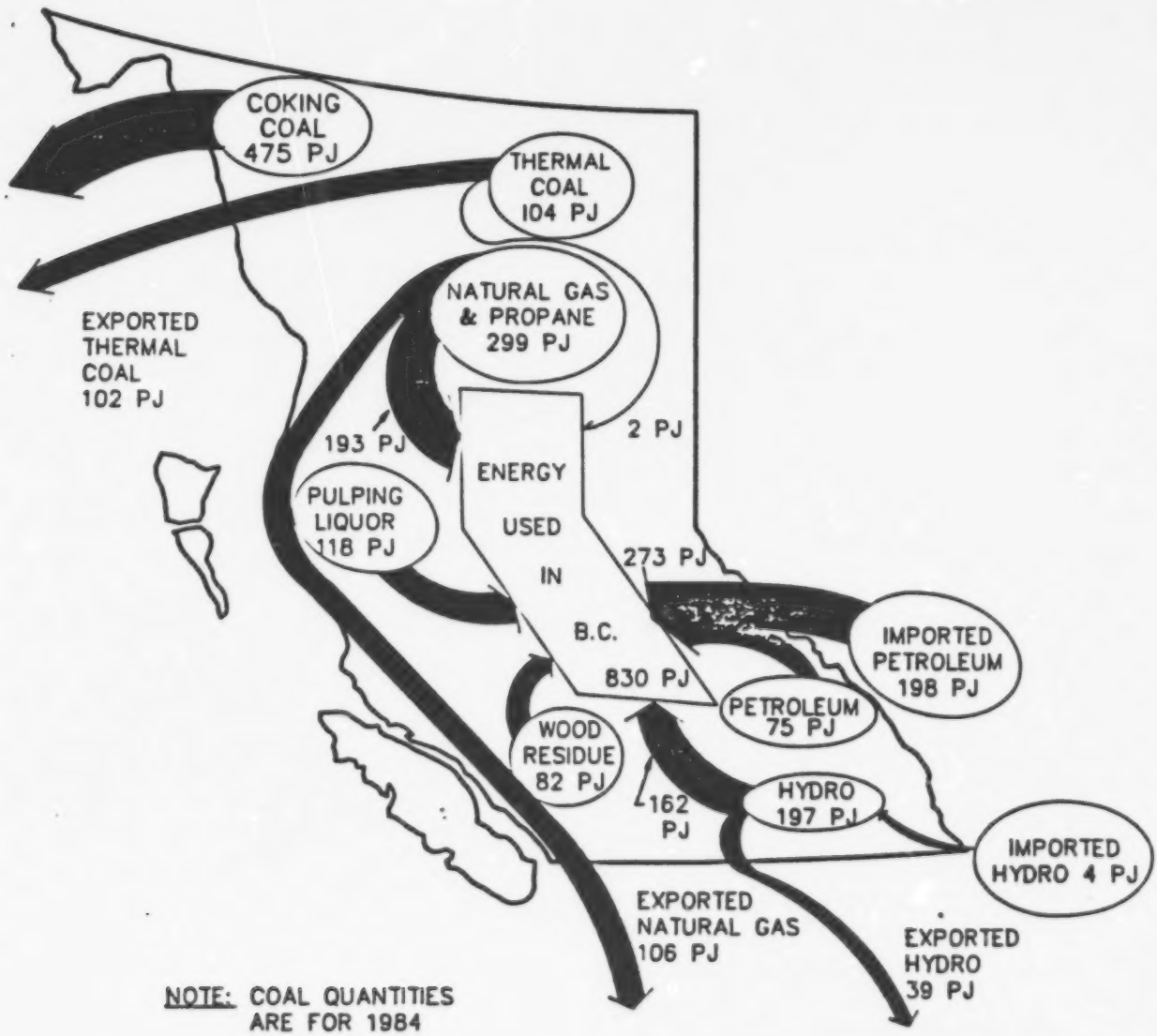
2.1. Review of the Present Status

The sources of energy used in B.C. are approximately as shown in the following graph:



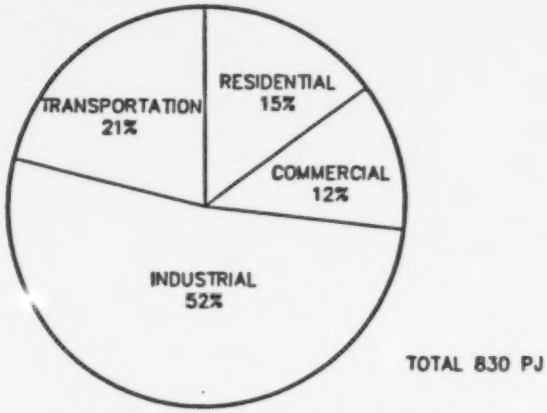
B.C. SOURCES OF ENERGY 1985

The distribution of energy produced by the province, imported into the province and exported from the province is illustrated as follows:



B.C. ENERGY BALANCE 1985

The use of energy within the province is illustrated by the following graph:



B.C. CONSUMPTION OF ENERGY 1985

The total energy presently used amounts to over 830 Peta Joules (PJ) with approximately 23% or 193 PJ being provided by Natural Gas.

Of particular interest to B.C. is its large consumption of petroleum fuel, as it imports approximately 73%. In contrast, B.C. has a large excess of natural gas. The province produces enough for its internal consumption and in addition has enough to export at a much higher rate than the present market will absorb.

The province has extensive resources of both natural gas and of coal. At the present rate of natural gas extraction there are approximately 30 years of remaining established reserves. However it should be pointed out that, historically, new reserves have been found at the same rate as the existing reserves have been used, thereby maintaining a 25 to 30 year reserve cushion. At the present rate of coal production there are 348 years of proven reserves of thermal coal and 96 years of metallurgical coal. At the present rate of production, the remaining established B.C. reserves of petroleum will last approximately 10 years.

Recommendation 1

That the B.C. Science Council recognize the strategic importance of research and development on natural gas fuelling of vehicles. A short term target is conversion of diesel engines for trucks and urban buses to natural gas. The long term objective would be to lessen the dependence of road, rail and marine vehicles on petroleum-based fuel, and to develop secondary industry for supply of conversion equipment.

The benefits of widespread conversion to natural gas are not only economic but also environmental, and would include not only lower prices for consumers but also increased employment and increased provincial revenues. These benefits can only be realized if development of the fueling station network goes hand in hand with the provision of equipment for engine conversion and control. Thus R & D to improve the required infrastructure should also be of high priority.

A fully integrated collaboration of government, industry and university must be in place for this effort to be successful.

Steps to Implementation:

1. The B.C. Science Council should convene a representative meeting to identify a group of industries, agencies and people who could form a consortium to carry out the necessary work. This consortium would include representatives of the Canadian Gas Association, the Federal Department of Energy, Mines and Resources, the B.C. Ministry of Energy, Mines and Petroleum Resources, the B.C. Research Council, and industries supporting the conversion of vehicles to natural gas fueling.

2. A management planning committee should be formed to identify opportunities and provide preliminary schedules and cost estimates for implementing the specific initiatives.

3. Given interim funds, a project team should be formed to put together a research plan, identifying the various initiatives, schedules, goals, etc. and putting together the applications for funding from the various government and industrial sources.

Recommendation 2

A Centre of Excellence for Energy Studies should be formed in which Industry would play a key part with collaboration from Government and Universities. It could, for example, coordinate cooperation between the funding agencies and provide a reliable source of information about all energy research. A financial commitment from Industry for at least part of the operation is perceived to be necessary for the success of such a Centre. Amongst the activities that this organization could carry out:

(1) Provide a proactive planning centre for energy research, development and demonstration in the Province. Over and above the opportunity of NGV mentioned in recommendation 1, there are some other areas of significant provincial interest:

   a) undertake research and development into the other Alternative Transportation Fuels;

   b) undertake research in so-called medium and long term areas like Hydrogen and Fuel Cells;

   c) provide an overview of the environmental aspects of energy and help identify specific new industrial opportunities for new processes or better controls.

(2) Provide a coherent source of information for all aspects of energy of interest to B.C. The educational benefits of this could be immense. It is possible that the Centre could provide experts to give formal courses of instruction at BCIT, colleges or universities.

(3) Provide a background of information about energy and how it should colour our future industrial strategy for the province. The Centre could provide a market research function to assist in identifying opportunities for new products.

(4) Provide reviews of the latest developments in specific energy fields of potential interest to B.C. and encourage communications between B.C. energy researchers.

(5) Provide space for selected research initiatives. It could be part or all of the site for the NGV initiative mentioned in Recommendation 1.

Steps to Implementation:

1. Form a small steering committee with representatives from industry and university and government. Objective: to identify all the agencies performing energy research and all the industries who might benefit from more up-to-date information.

2. Form an application committee, to prepare the basic constitution, the mission and goals, and the first order operating budget and the necessary space and staffing of the Centre.

3. Identify and recognize as integral members of the Centre all people undertaking bona fide energy research in the Province.

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4. Arrange for long term financing from a source of funds, including industries, Federal and Provincial governments, and support in kind from industry and university.

5. Appoint the Director and Administration which would include an Advisory Board representing all the interested parties.

The Province has a large variety of energy sources and problems that provide a unique laboratory for us to become world experts in possibly several niches of the energy technology. Many have already seized this opportunity to become world experts in the energy field. The province not only utilizes this know-how at home but also exports engineering consulting services and energy products all over the world. However, the energy field is changing very quickly: up-to-the-minute information as well as scientific research is required to keep the people and the industries who are involved in the energy field ahead technically and therefore competitive. Research and development in energy can be an "industry" in itself, providing marketable information and technology.

The Centre of Excellence for Energy Studies would also provide the province with the manpower resource that could be applied to solve energy problems quickly if a real emergency arose again. A physical location for this "Centre" would be more attractive than to just have the personnel scattering at other locations, but it would not be essential unless there were some new or expanded R & D effort that was identified to be carried out at this location. A consortium of industries or one industry willing to make a significant commitment would be an essential part of this collaboration.

Recommendation 3

The coal reserves of this province represent a huge legacy which should be exploited intelligently. The use of coal should continually be reassessed as new technologies develop. Consultations with the coal industry will be required for the implementation of coal R & D programs in B.C. Four specific initiatives are identified:

1. Each coal deposit has its own special characteristics. Research into characterization and utilization of the various deposits would improve the marketability of B.C. coals.
2. Research into beneficiation, transportation and handling of coal could lead to improved competition position of B.C. coals on open market.
3. Research into coal combustion, carbonization and conversion could develop new uses of B.C. coals.
4. Environmental research associated with coal industry would lessen the impact of mining and improve the acceptability of coal as a fuel and raw material for process industry.

Steps to Implementation:

1. The Coal Association of Canada has commissioned a report from Bob Granati, to study the present extraction technologies. After this report has been published, a collaborative committee should be formed to identify the specific research aims for the production, marketing and use of B.C. coal.

Recommendation 4

The B.C.Sc.C. should provide a stable long term financial base to support Energy R & D for both strategic research initiatives and curiosity driven research. The strategic initiatives will bring in the shorter term economic benefits, but the support of the curiosity driven research provides an important training ground for the engineers and scientists of the future.

There are many areas of energy research mentioned in this report that should get financial support. Who can predict where the next technological breakthrough will occur - in oil, gas, wood, solar, the so-called new technologies? The only safe prediction is that it will come from a bright individual. He therefore needs to be encouraged to do research. Several examples of this have been cited in this report.

Steps to Implementation:

1. Provide a larger funding base for energy research and explore possible joint collaboration with other agencies and research labs outside B.C.

2. Mount a coherent publicity campaign about energy issues, possibly using the Centre of Excellence for Energy Studies.

3. Cooperate with the educational and industrial communities to provide a coherent manpower infrastructure to broaden energy research.

4. Take a somewhat longer term view as to the viable economic payback for a given research project.

MEMBERS OF THE FORESTS AND FOREST PRODUCTS SECTOR PLANNING COMMITTEE

Chairperson:

Mr. Jim Earle	Canadian Forest Products Ltd.

Members:

Mr. Tony French	Forintek Canada Corp.
Mr. K. Illingworth	Ministry of Forests and Lands
Dr. C. Wilson	Crown Forest Industries Ltd.
Dr. J. Barker	Western Forest Products Ltd.
Mr. D. Barnes	MacMillan Bloedel Research
Mr. R. Craig	Carroll-Hatch (Int'l) Ltd.
Mr. Fred Veuger	CAE Machinery Ltd.
Dr. R. Kerekes	Pulp and Paper Centre, UBC

Consultant:

Mr. John Witt	Western Management Consultants

1. EXECUTIVE SUMMARY

The forest industry is the largest single economic sector of the provincial economy. It is the major employer, the driving force for many other economic sectors and is by far the largest part of the province's vital export industry. It competes in an expanding world wide market. Many strengths exist now in the B.C. forest industry which provide a basis for expanding investment and employment, not only in this sector but also in secondary, high technology industries.

This complex industry consists of separate yet interacting sectors namely, forestry, wood products, pulp and paper, machinery and equipment and consulting. The industry has not had to place a high priority on science and technology in the past due to the availability of large stocks of prime timber and the predominance of commodity products. Now each sector must increase its use of advanced technology to enhance the economic benefit to be derived from a changing and more expensive resource base and to add value to its products which compete on a world wide basis with products developed from new fibre sources.

The climate needs to be enhanced in the industry to foster further technological development within each sector and across the sectors. By using the local high technology industries, on a competitive basis, the B.C. forest industry can be at the leading edge of product and equipment developments and can fully coordinate its requirements with the local suppliers.

In order to continue its growth, all elements of the forest industry will need to agree on a long term goal for science and technology in the industry, encourage technological developments within each sector; promote greater interaction and co-ordination between its sectors; improve the economic return from its timber resource; add to its commodity product focus, quality value added products; and increase its technological competence and awareness, particularly the development of a positive environment for innovation in order to improve technology transfer.

In order to foster this climate for technology and innovation the forests and forest products sector needs to adopt the following mission for science and technology in B.C.:

> **"Recognizing the changing nature and increasing cost of its timber resource and the changing needs of its world-wide customers, retain competitively priced commodity products and develop value-added products by the increasing use of innovative technology, advanced machinery and systems, consulting, training and education."**

In order to achieve this mission, the Committee recommends that the forests and forest products sector focus on achieving the following five goals:

- a commitment to the continuing expansion and enhancement of the forest industry as the ongoing driving force for the B.C. economy;
- the continued development of value added forest products and an increase in the economic returns of the forest resource through the application of science and technology. This recommendation supports the thrust of the recent changes to the Forest Act in this province;
- an improvement in technological competence and awareness throughout the industry;

- an improvement in the transfer of technology to expedite economic benefit;
- an increase in the competitiveness of the forest industry by promoting the development of relevant high technology industries in the province.

This mission needs to be adopted and the goals reviewed and accepted by the industry, governments, universities, colleges, research institutions, advanced machinery and technology suppliers and consultants and then aggressively pursued and implemented on a co-ordinated basis. This committee recognizes that the forest industry across Canada and particularly in B.C. is currently focussing strategically on its future goals and strategies and that the recommendations of this report need to be coordinated fully with other initiatives.

7. SPECIFIC GOALS

The specific goals that need to be achieved in order to reach the overall mission are:

1. A continuation of the recognition that the forest industry is the driving force for the future of the provincial economy.
2. The addition of value to the forest products, the improvement of productivity and the improvement of management and utilization of the forest resource.
3. The improvement of technological competence and awareness throughout the industry.
4. The improvement of the transfer of technology.
5. The further increase in competitiveness of the forest industry by full utilization of advanced technology industries developed in the province.

1. Commitment to Continued Growth for the Forest Industry

The forest industry must continue to be recognized within B.C. as the driving force for the provincial economy and as an industry with an expanding future. A climate must be fostered to encourage investment and to fully utilize high technology.

ACTIONS

a) Continue the present public relations programs indicating the significance of the forest sector.

b) Establish a Council on Science and Technology in the Forest Industry comprised of representatives of the industry (CEO's, COFI etc.), government (Ministers of Forests, Economic Development, Advanced Education and Job Training and Regional Development), universities and colleges, unions, research institutions and major suppliers of advanced equipment and systems. This Council will agree on a

strategic plan for science and technology in the industry and regularly monitor progress and report on new requirements. In addition, it will advocate courses of action to the industry, to national and provincial governments, to the universities and colleges and to suppliers and will focus the interests of all those involved on the future of the industry.

c) Ensure that the industry is adequately represented in all other significant councils advising the Premier and the government.

d) Obtain overall agreement to the mission statement for the forest industry:

"Recognizing the changing nature and increasing cost of its timber resource and the changing needs of its world-wide customers, retain competitively priced commodity products and develop value-added products by the increasing use of innovative technology, advanced machinery and systems, consulting, training and education."

2. Add Value, Improve Productivity and Improve the Resource

This goal focuses on using technology to add value to the forest products so that B.C. is not only the volume leader in the world but also the value leader. These added value products will complement the continuing production of commodity products and will also develop jobs in secondary industries.

The forest resource is diminishing in quality, changing in nature and the costs of management and extraction are increasing. Research and development are needed to offset such changes and to improve the quantity, quality and cost of the fibre resource. This need is particularly evident when competition from other materials developed outside of B.C. is considered and the pressures of competing uses of the forests are increasing e.g. water, fuel, wildlife, recreation and community life.

The competition around the world from traditional forest products and from 'new' materials will require consistent improvements in the B.C. industry's 'competitive edge'. Science and technology can improve productivity and develop innovative products to meet customers needs.

ACTIONS

a) Increase the overall funding of R&D in the forest sector in B.C. from 0.55% of sales. The level of 0.55% of sales may continue to be appropriate for the commodity products, however significant increases will be required to develop value added products. Countries that are successfully competing with B.C. are spending 2.0%-2.5% on R&D. A careful assessment of needs is required in order to develop the specific target % to aim for and to develop a detailed strategic plan for the expenditure of these funds.

b) The federal government should clarify that it wishes to use tax incentives as a tool for economic expansion and should therefore attach a broad and consistent definition to R&D.

c) Provide financial incentives for all components of the forest sector to undertake R&D by tax incentives, write-offs and first user risk reduction programs.

d) Encourage cooperative research between users, suppliers and researchers by financial incentives. Encourage networking to share innovative information.

e) Investigate the provision of long term secure funding for research to buffer the ups and downs of industry cycles.

f) Continue the support for industry-wide research institutions and organizations and use their agreed lists of research priorities. FORINTEK, FERIC, PAPRICAN and the federal and provincial forestry organizations have lists of research projects developed with approximately 150 B.C. people involved. An R&D strategic plan would identify additional R&D requirements to develop new and innovative products.

g) Build the in-house research organizations of the companies to identify research needs, interact with research institutions, undertake competitive research and aid in technology transfer.

3. Improve Technological Competence and Awareness

The goal is to increase the effective use of science and technology in the forest industry and to fundamentally increase the visibility and acceptance of technology at all levels throughout the industry. An increased flow of technologically competent staff can be used by the companies and research institutions to staff the necessary increased research and development activity, but also they can staff the production facilities and act as 'enthusiastic receptors' of the transferred technology.

ACTIONS

a) More forest industry specific college and university trained graduates must be trained and absorbed by industry.

b) A Solid Wood Products course masters program is required, modelled on the very successful U.B.C. Pulp and Paper Master of Engineering Program.

c) Management, planning and marketing should be added to existing science and engineering courses.

d) Continuing education is required for those already in the industry in production and technology management positions.

e) Scholarship support for students must be increased.

f) Senior management of the forest companies must continue their emphasis on research and development by:

- focussing on technology at a senior management level in their organizations
- staffing up their technology teams to a 'critical mass'
- supporting their industry research institutions

g) Networking amongst forest industry research staffs must be encouraged.

4. Improved Transfer of Technology

It is vital that the increased research and development called for be transferred successfully into the production organizations on a timely basis. This will only be achieved if there is a major effort to involve industry throughout the R&D cycle, in the identification of projects, their completion and then their successful transfer to operations.

ACTIONS

a) Encourage participation by the users in the planning of research and development.

b) Promote cooperative research between users, researchers and suppliers.

c) Increase the numbers of trained scientists and engineers in production management positions.

d) Encourage an atmosphere of innovation throughout the companies.

e) Fund specific technology transfer programs.

f) Encourage networking to communicate positive results.

5. Increase the Competitiveness of the Forest Industry by Utilizing Advanced Technology.

The goal is to fully utilize the B.C. advanced technology community to improve the competitiveness of the B.C. forest industry. In turn, this will then foster the growth of these technology industries in B.C. so they can sell their products and services on a world-wide basis. These advanced technology industries include information technology, biotechnology, advanced materials, machinery and equipment suppliers. The advantage for the B.C. forest industry of using local suppliers is the opportunity for a technological edge, local after sales service, and participation in the development and planning of innovative products.

ACTIONS

a) Undertake a series of programs to promote interaction between the technology industries and the components of the forest industry.

b) Develop joint proposals between the advanced technology community and the forest industry for research projects.

c) Develop and if necessary, legislate financial incentives for the manufacturers of equipment and systems to undertake R&D.

d) Develop incentives for cooperative research involving users, suppliers and researchers.

e) Encourage research institutions to contract out to suppliers for specific research.

f) Improve the input of advanced technology companies to forest industry research organizations.

g) Sponsor forums for interaction between industry and its suppliers.

h) Support the recommendations of the attached report addressing specifically the development of the advanced machinery and systems support industry.

EQUIPMENT SUPPLIERS TO THE B.C. FOREST INDUSTRIES: CREATING A CLIMATE FOR INNOVATION

Study Group Members:

Mr. Richard Bryan	Council of Forest Industries of B.C.
Mr. Jim Earle	Canadian Forest Products
Mr. Tony French	Forintek Canada Corp.
Dr. Axel Meisen	Faculty of Applied Sciences, UBC
Mr. Fred Veuger	CAE Machinery Ltd.

Consultant:

Mr. John Madden	STC Enterprises

ABSTRACT AND PRINCIPAL RECOMMENDATIONS

The objective of the study was:

To recommend what actions might properly be taken to encourage a healthier, long term domestic equipment and software supply industry in B.C. in particular and in Canada generally, to service the forest industry sector, both domestically and outside Canada.

The investigation was by and large conducted during the months of November - December, 1987 and January, 1988, under the general guidance of a small study group appointed by the Science Council of B.C.

The group concluded that even the most generous interpretation of the data leaves the performance of the Canadian equipment suppliers taken as a group, with substantial room for growth.

It was concluded that there are significant opportunities for British Columbia which can be realized by a co-ordinated focus on the business of supplying capital equipment and software to the forest products industry. Benefits from such a focus include improvements to the competitiveness of the forest products industry through a leadership position in the use of equipment which adds value to the wood fibre harvested, reduces manufacturing costs and/or improves safety; as well as the creation new, high quality jobs in the equipment manufacturing and software sectors.

As a result of its investigations and deliberations, the Study Group made the following major recommendations:

1. **That those responsible for funding and managing the forest research organizations give serious consideration to setting aside funds to be devoted to contracted co-operative research programs with Canadian manufacturers.**

2. **That specific actions be taken to inspire a greater interest in careers in the forest sector and to improve the effectiveness of career training. These actions include the establishment of a university campus based industry research centre for wood products and harvesting technology, greater opportunity for appropriate continuing education, and the introduction of new graduate level programs in Forest Engineering and Advanced Technology Management.**

3. That forest product companies consider appropriate means to encourage a stronger spirit of constructive invention amongst their employees. The program should apply to inventions which the company itself may wish to pursue, as well as to other inventions which relate to the industry and which appear to have a commercial potential. The major consultant companies to the industry could also benefit from such a program.

4. That the Science Council of B.C., in co-operation with the Vancouver Wood Forum and other interested organizations, sponsor an ongoing series of roundtable discussions and workshops related to the employment of new technology in the forest products industry. These discussions should be structured in such a way as to attract researchers, consultants, operating management from the forest products industry, and manufacturers.

5. That the provincial government increase its support for the Science Council of B.C.'s Assistance Grants for Applied Research (AGAR) program in the forest sciences area. This program has already proved its effectiveness as a means of facilitating the conversion of applied research into successful product development.

6. That government give serious consideration to improving tax incentives to the forest products industry to invest in its own future, and to increase the domestic market opportunities for Canadian suppliers of capital equipment.

7. That governments consider the more extensive use of refundable tax credits, as an effective way of encouraging innovation.

8. PRINCIPAL RECOMMENDATIONS AND CONCLUSIONS

The study group concluded that there are significant opportunities for British Columbia which can be realized by a co-ordinated focus on the business of supplying capital equipment and software to the forest products industry.

As a result of its investigations and deliberations, the Study Group recommends[8]:

1. That those responsible for funding and managing the forest research organizations give serious consideration to setting aside funds to be devoted to contracted co-operative research programs with Canadian manufacturers.

2. That specific actions be taken to inspire a greater interest in careers in the forest sector and to improve the effectiveness of career training. These actions include the establishment of a university campus based industry research centre for wood products and harvesting technology, greater opportunity for appropriate continuing education, and the introduction of new graduate level programs in Forest Engineering and Advanced Technology Management.

3. That forest product companies consider appropriate means to encourage a stronger spirit of constructive invention amongst their employees. The program should apply to inventions which the company itself may wish to pursue, as well as to other inventions which relate to the industry and which appear to have a commercial potential. The major consultant companies to the industry could also benefit from such a program.

4. That the Science Council of B.C., in co-operation with the Vancouver Wood Forum and other interested organizations, sponsor an ongoing series of roundtable discussions and workshops related to the employment of new technology in the forest products industry. These discussions should be structured in such a way as to attract researchers, consultants, operating management from the forest products industry, and manufacturers.

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8. A number of lesser recommendations will be found in Section 7.

5. That the provincial government increase its support for the Science Council of B.C.'s Assistance Grants for Applied Research (AGAR) program in the forest sciences area. This program has already proved its effectiveness as a means of facilitating the conversion of applied research into successful product development.

6. That government give serious consideration to improving tax incentives to the forest products industry to invest in its own future, and to increase the domestic market opportunities for Canadian suppliers of capital equipment.

7. That governments consider the more extensive use of refundable tax credits, as an effective way of encouraging innovation.

MEMBERS OF THE INFORMATION TECHNOLOGY SECTOR PLANNING COMMITTEE

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Mr. Alvin Fowler	Services and Industry Liaison, UBC
Ms. Gail Gabel	Aandera Instruments Ltd.
Dr. Don George	Faculty of Engineering Science, SFU
Mr. Grant Gisel	Computech Consulting
Mr. Mike Hodson	Glenayre Electronics Ltd.
Mr. David Hughes	CUE Datawest Ltd.
Dr. Basil Peters	Nexus Engineering Corp.
Mr. Ed Piekaar	B.C. Telephone
Mr. David Sloan	Mobile Data International
Dr. Ken Spencer	Creo Electronics Corp.

Consultant:

Mrs. Noreen Angus	Noreen Angus & Associates

EXECUTIVE SUMMARY

- The development and manufacturing of Information Technology products is a **$1 billion** industry in British Columbia with more than **750** companies employing approximately **11,500** engineers, scientists, technologists, managers and skilled support staff during 1987.

- The Information Technology industry is "home grown" and "small business" with more than 90% of the companies employing fewer than 25 people.

- The Information Technology industry is growing at rates more than twice those of other manufacturing and primary resource based industries. If current rates of growth estimated at 20% to 50% in various sectors of the industry are maintained, the Information Technology industry will become British Columbia's third largest industry prior to 1995.

- Application of Information Technology to British Columbia's primary resource industries is necessary to the maintenance of their competitive position in world markets. The province has an opportunity to develop a strong secondary industry based on Information Technology applications that can also compete internationally.

- A growing number of companies in the Information Technology industry in British Columbia are competing successfully internationally in the areas of wireless and mobile communications, software applications and in large systems integration contracts.

- British Columbia needs to build on the strengths that have been identified in the Information Technology Industry in the province in order to keep pace with the global information technology revolution. A rapid and positive response by industry, government and educational institutions is needed with respect to the following recommendations:

  1. **Apply Information Technology aggressively in the province's primary resource industries to improve the competitive edge of those industries and to develop value added products, and in turn, develop a strong and unique Information Technology product and service industry catering to the needs of primary resource industries in the global market.**

  2. **Communicate commitment to invest in and promote the growth of the Information Technology industry through explicitly stated policies that recognize the importance of the industry to the provincial economy.**

3. Acquire and develop the experienced and specialized human resources that are critical to the growth of the Information Technology industry.

4. Increase the resources of the Science Council of British Columbia to implement effective policies and to develop appropriate programs for stimulation of the Information Technology industry.

5. Develop government and industry infrastructure within the province to reduce the risks and maximize growth opportunities for the Information Technology industry at all levels of the growth continuum.

RECOMMENDATION 1

Apply Information Technology aggressively in the province's primary resource industries to improve the competitive edge in those industries and to develop value added products, and in turn, develop a strong and unique Information Technology product and service industry catering to the needs of primary resource industries in the global market.

ACTIONS

1a) Undertake investigation of each of the major primary resource industries to identify needs and benefits of Information Technology applications and the need for increased awareness of Information Technology in the resource industries.

1b) Organize joint workshops with representatives from the Information Technology industry and each of the major primary resource industries to identify problems and opportunities to find mechanisms for joint development and implementation of solutions and increased awareness.

1c) Provide resources to the Science Council of British Columbia to establish sectoral committees to develop joint plans for effective application of Information Technology in primary resource sectors and development of unique products within the Information Technology sector.

1d) Provide incentives to post secondary institutions to offer more training including continuing education programs in applications of Information Technology, particularly in the areas of forestry, mining, agriculture, aquaculture and oceanography.

1e) Establish "first user risk reduction programs" to encourage primary resource industries to be more aggressive in applying new and innovative Information Technology developed in British Columbia.

RECOMMENDATION 2

Communicate commitment to invest in and promote the growth of the Information Technology industry through explicitly stated policies that recognize the importance of the industry to the provincial economy.

A major shift in attitude, and upgrading of status of the Information Technology industry within British Columbia is required. British Columbia, must give clear signals in the form of commitments and actions, that the information technology industry is considered vital to economic growth and therefore growth in provincial employment, productivity and income, not only in the sector itself, but also in the primary industrial sectors.

Recent initiatives in the form of the establishment of the Premier's Council on Science and Technology Policy Development, and the creation of the Advanced Systems Institute, are moves in the right direction.

Knowledge of and pride in achievements of the local information technologies are an important part of demonstrating commitment to the information technology industry. Science features, news of success, the B.C. Science Council Award, details of public and private sector activities and establishment of Science World, help towards raising the profile of this industry and high technology in general, both within and outside of British Columbia. Inclusion of the Information Technology theme in current government publicity and media programs and other advertisements will be a significant move in the right direction.

ACTIONS

2a) Industry and government need to agree upon and establish specific targets for growth in the Information Technology industry in two, five and ten year intervals.

2b) The industry needs an effective organization with adequate resources to develop and implement public relations programs designed to heighten the profile of the industry. This organization should also work with industry, government, post secondary institutions, and the convention industry to draw to British Columbia, major conferences and conventions in Information Technology.

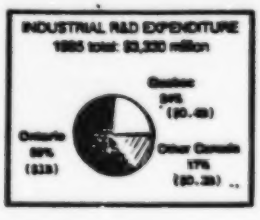
As shown in Table 15, Ontario draws by far the largest amount of Canadian industrial R & D expenditure (60% of total). However, the province of Quebec, which is a distant second, has made sweeping changes to provincial tax incentive programs with an aim to stimulating growth in the high technology industry by

drawing a significantly increased share of industrial R & D expenditure and talent. Similar changes are overdue in British columbia to set an environment for increased innovation, investment and product/service development and attraction of human resources in the Information Technology industry.

2c) Change the provincial tax structure and other financial incentive programs as other provinces including Quebec have done, to attract increased investment in Research and Development, capital and human resources.

EXHIBIT 15

TOTAL CANADIAN INDUSTRIAL INTRAMURAL EXPENDITURE



Changes in Tax Incentives

Initiative	Changes	Cost to Province
1. Industry & University R&D Tax Crtedit	From 10% to 20%	$43M
2. Tax Credit for Company sponsored R&D by full time professors	20% to 40$	
3. Income Tax Deduction for R&D flow through shares	33% limited partnerships	$46M
	66% in speculative University R&D	$ 6M
4. Two Years Provincial tax exempt for internationally reputed scientest working in Quebec		
5. Remove Provincial levies on Federal R&D tax credit		$ 7M
6. $17M fiscal 88 post-secondary funding for university/industry linkage		$17M

- **TABLE: Quebec's move to capture a larger share of industrial R&D in Canada for stimulating economic growth.**

RECOMMENDATION 3

Acquire and develop the experienced and specia zed human resources that are critical to the growth of the Information Technology industry.

The government in British Columbia needs to recognize that unlike other major industries in the province, the Information Technology sector is based primarily upon talented and highly educated human resources that are very portable and "footloose". Universities and the Information Technology industry throughout North America, compete to attract the talent and expertise that are required, by developing financial incentives, offering exciting career opportunities and promoting attractive lifesytles.

As stated in Section 3, although there is an adequate quantity of well qualified graduates available from various colleges and universities, most Information Technology companies in British Columbia have difficulty in attracting experienced and well recognized specialized technical, marketing and management personnel. The Information Technology industry depends heavily on people with advanced technical product and market ideas. British Columbia will continue to face stiff competition for the critical talent pool from more well developed and desirable centres such as Toronto, Ottawa, Oregon, Silicon Valley, etc. It is, therefore, essential that as well as trying to attract talent from outside British Columbia, we should also develop the necessary talent pool within British Columbia.

As stated in Section 4, one of the major difficulties in attracting talented and experienced personnel to British Columbia is the apparent concern of having to relocate to eastern Canada or the United States at significant costs, if the company or the job does not work out. To minimize the risk, one approach may be to establish an insurance program with contributions from industry and government, which will guarantee relocation costs if an equivalent job for an individual cannot be identified within a reasonable period of time.

ACTIONS

3a) Develop a range of incentives, including income tax relief and industry/government sponsored bonuses and insurance programs to attract well recognized marketing, managerial and technical talent and to mitigate the perceived risks of relocation to British Columbia.

It is essential that academic institutions continue to emphasize general education and skills for students and maintain a certain amount of autonomy in developing their curriculum. However, mechanisms must be found for industry,

academic institutions and government to jointly focus additional resources in specific areas which are critical to the local and national industry and to the economy. Creation of Funds for Excellence is one good example of how the above initiatives can be achieved.

3b) Recognizing that CO-OP programs cost more to operate than traditional programs, but do contribute to acceleration in the development of specific skill sets required by the Information Technology industry, co-op programs should be promoted and expanded with increased levels of funding.

3c) Establish a joint industry, academic, and government group, to continuously monitor, identify, implement and fund effective continuing education programs focused specifically on developing expertise in key areas of technology, management and marketing. Suitable industry representatives should be encouraged to provide courses under the overall direction of the Academic Coordinator.

3d) Increase government support, through direct subsidy or tax incentives, for employer-based training in developing necessary technical, marketing and management expertise.

3e) Redirect government and industry funding to post- and pre-secondary institutions to encourage courses and research in specific areas of information technology which are a key to growth in the industry.

3f) In order to meet the industry's need for improved and expanded levels of management, marketing and specialized technical expertise, post secondary institutions should develop an agressive plan that can be supported by both government and industry.

RECOMMENDATION 4

Increase the resources provided to the Science Council of British Columbia for the specific purpose of implementing policies and developing programs directed toward stimulation of the Information Technology industry.

In recent years, the Science Council of British Columbia and its Information Technology sector, have tended to be reactive in supporting the growth of Science and Technology in British Columbia rather than proactive in providing leadership to governments and industry. Current budgets provided to the Science Council of British Columbia do not reflect the current or potential contribution of the high technology industry to the economy, more specifically in the area of Information Technology.

The Science Council and the various sub-committees (sectors) are composed of prominent and influential members of the industry, academic community and government. The collective talent, with the appropriate mandate, encouragement and resources, can become a powerful mechanism in both strategic planning and implementation of policies and programs promoting growth in the industry. It is our understanding that the government is re-writing the Science Council Act to provide the Science Council of British Columbia with a much stronger mandate and opportunities to play a more pro-active role in the growth of science and technology within the province.

ACTIONS

4a) Increase funding to the Science Council of British Columbia to allow significantly more investment in all programs relating to the stimulation of the Information Technology industry.

The Information Technology industry in British Columbia has developed a number of strengths in specific areas. Recognizing that rapid growth and achievement of world leadership in a few areas of information technology can only be achieved by focussing science resources in areas of strength, the Science Council of British Columbia should focus their resources in the following areas:

- Wireless and mobile communications technology
- Applications software development
- Information technology applications to British Columbia's primary resource industries.

In order to prepare for the future, investment must be made in a number of emerging technologies which will become critical to the development of products in key niche.

Although further investigation is required to develop a comprehensive list of critical emerging technologies, the following technologies should be considered for investment:

- expert systems applications
- software development methodology, tools, techniques and systems
- wireless and R.F. technology
- information and speech coding synthesis and recognition
- electro optics
- mechatronics

4b) When coupled with technical research and development, market research should be included as a legitimate activity in funding Information Technology projects under the Science Council of British Columbia's A.G.A.R. program.

4c) Provide resources to the Science Council of British Columbia's Information Technology sector to continuously monitor and identify opportunities and problems in focussing Science Council and government resources.

4d) Provide necessary resources and seed money to the Science Council of B.C. which would be used to attract federal government grants, R&D funding, and financial assistance for provincial industry and university communities.

4e) Ensure that the Science Council fully coordinates its activities with those of the Ministry of Economic Development to encourage full recognition of marketing in the implementation of these recommendations.

RECOMMENDATION 5

Develop government and industry infrastructure within the province to reduce risks and maximize growth opportunities for members of the Information Technology industry at all levels of the growth continuum.

Success in the Information Technology industry depends upon a company's speed and effectiveness in moving the business over a number of major hurdles that are encountered by every company. Success during the initial technical feasibility, proof phase is as critical as the later market and distribution channel development phases.

Although there is a strong undercurrent of entrepreneurism in British Columbia in Information Technology, most of the companies in the province are relatively small and have been formed within the last 5 - 10 years. On the average, Information Technology companies in Quebec and Ontario are 30% to 80% larger (in terms of number of employees), than companies in British Columbia. Companies in British Columbia, in general, face a major challenge and difficulty in growing beyond what is considered a medium sized company (less than 1000 employees). None of these medium sized companies would be considered medium or large on a world wide basis.

Start up companies face different kinds of challenges. Access to government labs in Ottawa for technology and/or research and development support, and access to government funding for market development, are virtually taken for granted by most start up companies in the Ottawa - Toronto - Montreal golden triangle. Such a well developed infrastructure is not readily accessible to a start up company in British Columbia. Searching through the maze of assistance, financial or otherwise that may be available both locally and elsewhere, is often a major headache for an entrepreneur.

We recommend development and consolidation of existing infrastructure within the province to assist start up companies in establishing a strong foothold and the support of small and medium size companies to achieve levels of growth that are competitive in the global Information Technology industry.

Exhibit 16, although not all inclusive, shows various phases, where Information Technology companies of various sizes may require assistance and support to sustain continued growth.

In addition to the activities shown in the Exhibit, the proposed Wireless Communication Centre and the Pacific Microelectronic Corporation, which are still under consideration, are expected to be significant additions to the local support structure for the information technology industry.

EXHIBIT 16

KEY SUPPORT REQUIREMENTS DURING DIFFERENT PHASES OF BUSINESS DEVELOPMENT IN A TYPICAL INFORMATION TECHNOLOGY COMPANY

	Start-Up 0-10 Employees	Small 10-100 Employees	Medium 100-1000 Employees
Research and development funding and incentives that include market research	X	X	X
Office space and shared infrastructure including equipment labs and business advice and expertise, recruitment of technical personnel	X		
Business plan development	X	X	X
Knowledge of raising risk capital	X	X	
Software development tools	X	X	
VLSI design tools and facility	X	X	X
Manufacturing and packaging infrastructure	X	X	X
Export Market Development	X	X	X
Development of Sales and Distribution channels	X	X	X
Market and Sales Training	X	X	X
Formation of Joint Ventures and Partnerships		X	X
Attraction of experienced management and assistance with strategic planning		X	X
Establishment of first customer for testing and demonstration of new products and services.	X	X	

ACTIONS

5a) An individual with information technology and business development background should be appointed to:

- **identify industry requirements for support,**
- **maintain an inventory of existing infrastructure,**
- **develop and maintain a data base containing information with respect to type of products produced, number of employees, annual sales volumes, research and development expenditures, etc., for all companies in the Information Technology industry in British Columbia,**
- **focus the activities and resources of the Discovery Foundation, Electronic Manufacturers Association, the Microelectronic Society and the Software Industry Development Association in identifying problems and opportunities, and developing strategic plans.**

Small start up companies in the information technology industry frequently have difficulty in raising the required capital. The Cal Tech Venture Forum in Los Angeles, California was formed to address the problems experienced by these companies. In the Cal Tech Venture Forum, company executives give a short presentation to an audience of institutional investors, bankers, corporate investors, and venture capitalists who would not only develop a good understanding of business opportunities, but also provide useful critique and advice to the companies. Such a forum may provide more exposure and opportunity to a small company in an afternoon than they would normally get in a year of constant meetings to find potential investors.

5b) Establish a venture forum including major banks, venture groups, and the Vancouver Stock Exchange to allow Information Technology companies (requiring risk capital to get exposure on a regular basis).

5c) Establish a joint industry-government association to take a pro-active role in pulling various Information Technology companies together in developing joint bids for major national and international contracts and business opportunities.

5d) React quickly and positively toward local industry initiatives to establish appropriate Centres of Excellence such as the Wireless Communication Centre, Pacific Microelectronics Corporation and the MacDonald Dettwiler's Resource Information and Management System.

5e) Add an Information Technology officer to the existing Economic Development Office in Ottawa, charged with the responsibility of drawing a larger share of Federal R & D and infrastructure grants, with assisting Information Technology companies in British Columbia in gaining access to opportunities in Eastern Canada and identifying joint venture opportunities for local B.C. companies.

5f) Develop a provincial government bid and performance bond program to assist smaller companies in bidding on contracts in export markets.

MEMBERS OF THE MANUFACTURING AND MACHINERY SECTOR PLANNING COMMITTEE

Chairperson:

Jim Gregory	Canadian Occidental Ltd.

Members:

Dale Cherchas	Dept. of Mechanical Engineering, UBC
John Dill	Engineering Science, SFU
Jim McEwen	Dept. of Biomedical Engineering, UBC
Carl Hunter	Wagner Engineering Ltd.
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Don McLean	McLean Engineering Ltd.
Ron Stern	Engineering Technology, B.C.I.T.
Gerry Stickland	Epic Data Inc.
Bob Williamson	RSI Robotic Systems
Blair Wilson	Canadian Manufacturing Association B.C. Division

Consultant:

Mr. John Witt	Western Management Consultants

1. EXECUTIVE SUMMARY

The manufacturing sector of the B.C. economy involves the major driving forces for economic growth and increased employment of the province namely: lumber, pulp and paper, chemicals, minerals, agriculture, aquatic resources and food, electronics and communications, manufactured goods and health products.

Science and technology must play a vital role with the 30 large manufacturers that dominate the resource industries and amongst the balance of the 4,000 small companies that make up the rest of manufacturing. Major opportunities exist in training people specifically in manufacturing, in providing a focus and a plan for science in manufacturing, encouraging technology transfer, developing robotics and automation, networking available support services and launching new initiatives in health care.

The committee believes that by supporting and encouraging these initiatives, the manufacturing sector can develop and bring increased revenue and jobs to the province.

6. RECOMMENDATIONS

In order to increase the impact of science and technology on the vital manufacturing sector of the province's economy, the committee evaluated the opportunities outlined in Section 3 and recommends the following, listed in order of priority. The committee strongly recommends that industry continue to be involved in all of these initiatives, either by direct participation or on advisory boards.

1. The development and implementation of an integrated strategic plan for science and technology in manufacturing and the identification and appointment of a 'champion' to make the plan happen.

2. The launching of a major focus on biomedical devices as an area of excellence in B.C. and a potential new diversification in the province's economy.

3. The development and implementation of manufacturing specific education and training programs at colleges, institutes and universities, the implementation of technology transfer programs and a focus on planning, marketing, management and entrepreneurship in all manufacturing training and education.

4. The development and implementation of a joint SFU/BCIT small manufacturing technology centre to assist the large number of small manufacturers to test their ideas and get started and the spreading of this concept to other colleges through the province as it becomes accepted and useful.

5. The launching of a world class robotics and automation initiative focussed on the resource industries' needs and the expertise at UBC.

6. The implementation of innovative approaches to provide a network of contacts and information for B.C. manufacturers so that they become aware of B.C. support resources that can participate in their manufacturing process.

7. Continuing the development of applications for CADCAM use in specific manufacturing industries.

8. Inreasing the R&D funding for manufacturers and communicating more effectively the availability of these funds.

1. Strategic Plans and Resources

The committee recommends that strategic plans for science and technology be implemented and that responsibilities and time frames be established for all key actions. This strategic plan must include marketing considerations as these are vital in this sector. There is an urgent need for coordination, cooperation and collaboration to make an impact. In addition, the committee recommends that an experienced, credible manufacturing specialist be recruited jointly by the CMA and the Science Council of B.C. to act as 'champion' for manufacturing science and technology in B.C. to make sure the recommendations of this report happen. This 'champion' must be knowledgeable of small companies, sensitive to B.C. issues and have linkages to knowledge outside of B.C.

2. Biomedical Engineering

The committee supports the initiative developed by industry, the hospitals and UBC to resource and expand a focus on biomedical engineering. The province has a demand for these developments, there is a large world-wide market, the leaders in required expertise are located in the province and the parties involved need to cooperate and coordinate in the proposed biomedical engineering initiative. There is a need to develop a sterlization plant in B.C. to move the pharmaceutical and medical devices and supplies industry forward.

3. Manufacturing Specific Training

Manufacturing courses need to be developed and expanded at the colleges, institutes, the universities (graduate and undergraduate degree programs including provision for coop students) and in industry through

continuing education. Specific training is also required to increase the number of skilled tradesmen and upgrade skills of existing tradesmen. The apprenticeship program should be reinstated at a comparable level to competitive programs with continued funding. These courses must focus specifically on manufacturing as an area of specialty but they must also include major elements of marketing, planning and management so that graduates who become involved in the large number of small companies in the province can comprehend the full business impact of their manufacturing activities. Continuing education programs in manufacturing and management need to be developed and implemented for those involved in manufacturing.

In addition, specific approaches involving the colleges, institutes, universities, research organizations and industry must be developed to better transfer technology to the companies involved in manufacturing in B.C.

4. Manufacturing Technology Support Centre

The committee supports the initiative to utilize existing facilities at BCIT and SFU for a small manufacturers technology centre. This support centre will have an Advisory Board with representation of industry to ensure that it is always needs driven. This centre is intended to provide teaching facilities, support services and training, expertise, education, research and technology transfer and access to advanced equipment. This will enable start-up manufacturers and those with limited facilities and equipment to bring their manufacturing ideas and problems into an environment where they can physically test them with experienced help at hand. Suppliers of equipment and systems will be encouraged to use the centre to display their products, training will be

provided and a focus provided for the small, start-up manufacturers to develop their ideas to the manufacturing stage. The possibility of linking this initiative with the Advanced Systems Institute will be explored. As the centre becomes proven, this concept can be extended to include other colleges throughout the province.

5. Automation and Robotics Laboratory

The committee supports this initiative which will involve a focus on the robotics and automation needs of the resource industries and involve resource organizations and companies, expertise now available at UBC and the resources of the Advanced Systems Institute of B.C. and particularly the Centre for Integrated Computer Systems Research (CICSR) at UBC.

This focus involving the resource industries and the University will allow the resource industries to identify their research needs involving robotics and automation and will pull together the various elements at the university with required expertise. The projects will focus on the generic tasks of materials handling and manipulation for the resource industries and robotic assembly and inspection, arc welding and robotic machinery operations for the secondary manufacturing sector. The tie-in to the Advanced Systems Institute will allow these developments to be disseminated to a broader group in the province. In addition, industry organizations such as Feric, Forintek, Paprican, Mining Association, etc. will be involved to increase industry involvement.

The plan is for this focus on robotics in the resource sector to expand, in time, to enhance the other sectors of the provincial economy to fully utilize the emerging technologies identified in the resource industries.

6. Network and Communications

Because of the very large number of small companies in the B.C. manufacturing sector, it is extremely difficult for each of them to know the complementary activities available to them in B.C. Because of this, many of the companies involved in complex manufacturing involving a number of materials and processes go outside of the province for participants in their manufacturing process. They are unaware in many cases that the participation or support services they require are located in the province.

This problem is not easy to address, the committee believes that although directories, both hard copy and computer based, may assist, the real networking occurs when people meet others face to face. Therefore the recommendation is to charge and fund CMA, Science Council of B.C., universities, institutes, colleges and industry associations with the task of regularly calling seminars, trade shows, open houses, dinners, lunches and site visits. This effort will cause manufacturers to meet each other and to identify participants and support services to assist their production activities. In addition, information on support services available from outside B.C. is also required for these manufacturers.

The proposed manufacturing science and technology champion could be a proactive broker to make sure these contacts occur on a one-on-one basis. In addition, the committee feels that a comparison activity to the 'B.C. Trade Offices' overseas is needed in B.C. itself to ensure that opportunities for B.C. manufacturers are not overlooked.

7. CADCAM

Continue the development of specific CADCAM research applications for B.C. industries and particularly transfer this technology to a larger percentage of B.C.'s manufacturers. This work is underway in conjunction with industry at BCIT, at CART in Prince George, at the University of Victoria and at Camosun College.

8. Funding and Support

Gradually increase the funding from all sources for manufacturing research and development up to the Canadian average of 1.4% of Gross National Product. Particularly launch a communications and assistance program so that a larger percentage of the 4,000 manufacturers in the province apply for and obtain research funding, particularly from the Science Council of B.C. Investigate a first user reduction program where industry shares the risk and pays back the funding if the project succeeds. Provide small companies with support for funding, understanding of financial organizations and tax incentives. Support CMA investigations of tax incentives for R&D.

MEMBERS OF THE MINING, MINERALS AND METALS SECTOR PLANNING COMMITTEE

Chairperson:

Brian Parrott	Mining Association of B.C.

Members:

Keith Brimacombe	Centre for Metallurgical Process Engineering, UBC
Bruce Hawbolt	Dept. of Metals and Materials Engineering, UBC
George Poling	Dept. of Mining and Mineral Process Engineering, UBC
Cory Sibbald	Teck Corporation
Al Sinclair	Dept. of Geological Sciences, UBC

Consultant:

Mr. John Witt	Western Management Consultants

I EXECUTIVE SUMMARY

The B.C. mining, minerals and metals industry has been and will continue to be a major part of the B.C. economy and one of the key provincial players in regional development and exports.

The industry will require a growing focus on science and technology in order to remain competitive and to develop new and innovative products in the face of increasing competition from developing countries. Companies in this sector generally have not placed a high priority on basic research and development. A substantial amount of site specific feasibility and ongoing development work that is undertaken could be classed as applied research. Many existing research centres, provincial and national, have capacity available that can be directed towards an increased, minerals-related R&D effort in this province.

In order to promote the urgency and benefits of increased R and D in the B.C. mining, minerals and metals industry, attention first must be on providing B.C. companies with a focal point for R&D in the province. An R&D coordinator must be funded who is cognizant of the workings of both the industry and research organizations. His aims will be to:

- identify the R&D needs of the B.C. mining, minerals and metals industry;
- identify research organizations that can satisfy those needs;
- develop the necessary funding;
- bring together those groups who can most effectively interact relative to specific R&D needs;

- provide a network of R&D information to B.C. companies and research centres;
- coordinate with other research-related organizations of interest to the B.C. minerals industry (e.g. MITEC, CANMET and the Coal Association of Canada);
- assist with technology transfer.

Funds must be directed to R&D with the potential of benefitting the B.C. mining, minerals and metals industry. About twice the present level of funding will bring us to the national average.

Two proven, successful means of promoting research focussed on industry's problems are through the establishment of

1) industrial research chairs affiliated with the universities, and
2) centres for advanced technology.

Proposals for both types, relating to the B.C. mining, minerals and metals industry, are being prepared at the present time and will require input and financial support.

VI RECOMMENDATIONS

The committee recognizes that it will be a major task to increase the amount and effectiveness of R&D in the B.C. mineral industry. Consequently, we limit ourselves to four recommendations that we feel can have a dramatic and positive impact on the expansion of mining, minerals and metals related R&D in British Columbia over the near term.

1. Establish and fund an R&D coordinator in B.C. for the B.C. mining, minerals and metals industry.
2. Support the establishment of Industry research chairs directed towards R&D in the mining, minerals and metals industry.
3. Provide an increase in resources applied to R&D in the mining, minerals and metals industry.
4. Support the establishment of centre(s) of excellence in fields related to the mining, minerals and metals industry.

1. R&D Coordinator

This position is critical to the theme of this report. The individual must be familiar with procedures and problems of the mining, minerals and metals industry and must be knowledgeable in methodologies and requirements in conducting research. The coordinator should be funded jointly by industry and government and should be located where he has easiest access to information and lines of communication. This recommendation should be coordinated with the current initiative of the Mining Suppliers and Contractors Association of B.C.

Duties of the coordinator will be to:

1) Identify the R&D needs of the B.C. mining, minerals and metals industry through forums, workshops, etc..

2) Identify research organizations that can satisfy those needs.

3) Develop the necessary funding.

4) Bring together those groups who can most effectively interact relative to specific R&D needs.

5) Provide a network of R&D information to B.C. companies and research centres.

6) Coordinate with other research-related organizations of interest to the B.C. minerals industry (e.g. MITEC, CANMET and the Coal Association of Canada).

7) Assist with technology transfer.

8) Fully investigate tax incentives and other advantages for the industry to invest in R&D.

2. Industry Supported Research Chairs

Industry supported research chairs are a remarkably effective means of directing research to specific problems as is so ably demonstrated by the Stelco-NSERC research chair in process metallurgy in the Centre for Metallurgical Process Engineering at UBC. Possibilities for industry supported chairs include geostatistics, industrial minerals, advanced industrial materials processing, surface mining and minerals processing. The committee strongly supports the concept of such chairs but recognizes that they must be implemented in response to a demand from industry if they are to be successful, if for no other reason than that a significant proportion of the funding must be provided by industry. The Science Council of B.C., through the Mines, Minerals and Metals Grant Selection Committee, should involve itself in formulating and financing appropriate research chairs in cooperation with NSERC and

representatives from the minerals industry. It is important to recognize that the concept of a research chair may include several individuals. Such a nucleus of personnel devoted to a specific line of inquiry can be enormously productive.

3. Substantially Increased Investment in R&D

Efforts must be made to increase the resources applied to mining, minerals and metals R&D in British Columbia. This increased support must come from all those involved with the industry. The Science Council of B.C. can take the lead in this matter by substantially increasing its level of funding through the Mines, Minerals and Metals Grant Selection Committee. Industry and government can also be encouraged to support specific projects with continuing funds.

4. Centres of Advanced Technology for Mining, Minerals and Metals Research

MITEC has proposed the establishment of a number of specialized research centres across the country as a means of promoting and expanding research and development that will be beneficial to the Canadian mining, minerals and metals industry. This committee strongly supports MITEC's concept of regional centres of expertise in emerging technologies and recognizes the need for and benefits of such centres in British Columbia.

Proposals are now being prepared for several centres with relation to the B.C. mining, minerals and metals industry.

1. A centre for advanced technology in remote sensing, (has relation to the industry through the potential application to mineral exploration).

2. A centre for advanced technology for rare and precious metal resources (clearly includes a diversity of undertakings of interest to the entire spectrum of the industry).

3. A centre for advanced materials (has been proposed to the provincial government from UBC).

Recent publicity by the federal government indicates that federal funding will be forthcoming for such centres in the near future. The Science Council of B.C. should maintain an informed awareness of progress in this matter and endeavour to support worthy proposals that will have a significant positive influence on R&D in British Columbia.